

**MACAÉ MERCHANT POWER PLANT**

**INTERNATIONAL FINANCE CORPORATION (IFC)**

**- WORLD BANK GROUP -**

**ENVIRONMENTAL AND SOCIAL APPRAISAL**

**SUPPLEMENTAL ENVIRONMENTAL  
IMPACT ASSESSMENT REPORT**

**ECOLOGUS ENGENHARIA CONSULTIVA**

**APRIL 2002**

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**Brazil: Macaé Merchant Power Plant**

**SUPPLEMENTAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT**

**EXECUTIVE SUMMARY**

**1. Introduction**

This report was prepared to partially fulfill International Finance Corporation (IFC)/World Bank requirements for due diligence in financing a 870 MW power plant for El Paso Corporation, called the Macaé Merchant Power Plant. The Macaé Merchant Power Plant is located within the municipality of Macaé in the state of Rio de Janeiro, Brazil. The report specifically describes the project’s environmental and social programs from plant design and site selection to construction and plant operations.

The Environmental Impact Statement (EIS) was prepared in October 2000 in accordance with Brazilian Environmental Assessment (EA) regulations for the original 700 MW project. The EIS was amended in December 2001 for the expansion phase to 870 MW total. Both reports were reviewed by the designated Brazilian environmental regulatory agency (FEEMA) and applicable environmental licenses were issued as follows:

**ENVIRONMENTAL LICENSES**

REF. # FEEMA	TYPE OF PERMIT	SUPPORT DOCUMENT / DATE	ASSESSED SCOPE OF PROJECT				ISSUANCE DATE
			PP	TL	WP	GP	
013/2001	LP	EIA/EIS – Oct/00	X	X	X	X	3/13/01
089/2001	LI-Earthworks	Earthwork design Mar/01	X	X			3/19/01
Permit issued to CEG-Rio	LI- Gas Pipeline	Application for LI				X	5/13/01
125/2001	LI- Full Project	PBA – Mar/01	X	X	X		4/06/01
439/2001	LO- Full Project (700 MW)	Application for LO Sep/01	X	X	X		10/31/01
Permit issued to CEG-Rio	LO – Gas Pipeline	Application for LO Sep/01				X	10/31/01
E07/202534/01	Formal notification of approval for expansion to 870 MW <sup>(1)</sup>	Submittal of EIS amendment	X	X	X		2/14/02

LP – Preliminary License; LI – Installation License; LO – Operation License; EIA/EIS – Environmental Impact Assessment/Statement; EMP – Environmental Management Plan; PP – Power Plant; TL – Line Transmission; WP – Water Pipeline; GP – Gas Pipeline; FEEMA – Rio de Janeiro state environmental regulatory agency; CEG – Rio de Janeiro state company for gas distribution.

Note 1: This notification meets LI requirements for 870 MW

In addition to the environmental permits listed in the table above, El Paso applied for permission to use water from the Macaé River, from SERLA (Rio de Janeiro State Water Agency) in October 2000. Formal approval was granted in September 2001. The water needs for the 870 MW plant will be indicated within the approved water permit.

The Supplemental EIA report was prepared in March 2002 to demonstrate that the project was designed following World Bank/IFC safeguard policies and environmental, health and safety guidelines, as well as to outline the environmental management system for the project.

The Executive Summary discusses key findings and recommendations for the EIS, a modified EIS, the Environment Management Plan (EMP) and a Supplemental EIA.

## 2. Project Description

- **Plant Site** – The Macaé Merchant Power Plant is located near kilometer 164 of BR 101 federal road, in the Severina district of the municipality of Macaé, in the state of Rio de Janeiro, Brazil on land owned by El Paso Rio Claro Ltda.
- **Water Supply** -The water used to supply the plant is taken directly from the Macaé River, which is located about 5 kilometers from the Macaé Merchant Power Plant site. The water pipeline is located along a strip of land acquired by El Paso Rio Claro Ltda that links the plant site to the riverbank.
- **Gas Pipeline** – The gas pipeline for the project begins at an interconnection valve located in the existing gas pipeline GASDUC, some 9 kilometers southeast of the plant site. From that point, the gas pipeline route runs nearly parallel to the right-of-way of an existing water pipeline until it reaches the plant site. Along that route, the gas pipeline crosses rural areas covered by grasslands where there are no nearby towns or communities.
- **Transmission Line** - A 345 KV transmission system owned by FURNAS (the regional power transmission company), crosses the Macaé Merchant site, preventing the need to construct any additional transmission lines outside of the plant site. All interconnection lines are located within the plant grounds.
- **Access Road** - The plant is accessible from the BR-101 federal road. Following standard requirements of the DNER (National Road Department), an exit ramp was constructed at the plant entrance. All mandatory DNER procedures were followed by El Paso during both design and construction of the ramp.
- **Technology Choice** - The final project consists of 20 GE LM 6000 Turbines, (16 as initially planned, plus 4 as per project expansion), operating in simple cycle. These turbines are the most efficient equipment for the considered power range (40 to 70 MW). These turbines were selected for two reasons: first, the simple cycle technology will allow the plant to operate in a very flexible manner, which will be critical to its success as a merchant facility with no long-term off take contracts; secondly, the project required fast track implementation in order to address the power supply crisis in Brazil; the simple cycle system has additional characteristic of quick turn around time in ordering and receiving the equipment.
- **Project ownership** - EL PASO RIO CLARO LTDA. which is part of EL PASO ENERGY INTERNATIONAL, is the company responsible for the design and implementation of the Macaé Merchant Power Plant.
- **Project development status** - Construction of the initial 16 turbines for 700 MW is about to be completed, with some units already in operation. The expansion to 870 MW (with an additional 4 units) was initiated in February 2002. The project was licensed by FEEMA in compliance with all steps of the environmental permitting process.
- **Fuel Supply** - Fuel for the project is associated natural gas produced offshore in the oil and gas production fields of Petrobras in Campos Basin and brought on shore by submarine gas pipelines up to Cabiunas Station in the city of Macaé. Petrobras is responsible for all gas supply. Through a contractual agreement with Petrobras, the Macaé Merchant Power Plant has been guaranteed a supply of natural gas for use throughout its life cycle. This commercial agreement was made in accordance with federal regulations.

- **Electricity Sales** - The Macaé Merchant Plant is designed to meet variable energy demands established during peak periods, or basic energy demands during drought periods when hydropower plants have their generation capacity reduced. The Macaé Merchant project is among the projects included in the Brazilian long-term power generation plan, designed to improve energy distribution within the Southern/Southeastern /Midwestern integrated electrical systems. The Macaé project will not operate with an assured long-term demand contract. As a merchant project, its energy will be sold on the open market.

### 3. Policy, legal and administrative framework

- **Brazilian energy policy**

The Macaé Merchant project is part of the Ten Year Power Sector Expansion Plan (2000-2009) created by Eletrobrás. The plan emphasized the need to expand the amount of energy generated by thermal power projects in Brazil, by increasing the present thermal power capacity of 5,867 MW to 25,182 MW by the year 2005. The larger part of the planned increase would take place in the Southern, Southeastern, and Midwestern regions where the capacity of thermal plants should be increased from the present 3,809 MW to 20,249 MW between the years 2000-2005. The Macaé Merchant project was also included in the PPT (Priority Program for Thermal Power Plants), which implies that the plant was to be implemented as early as possible.

- **Brazilian environmental regulations and environmental permits**

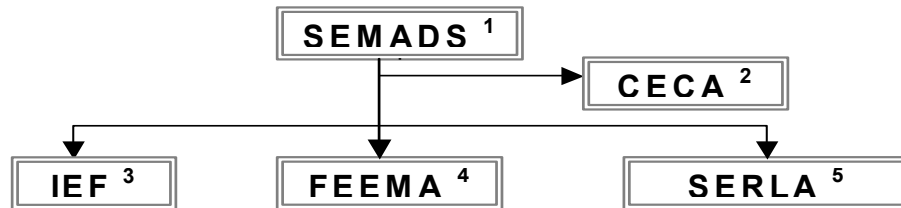
The basis for environmental licensing in Brazil was established by the National Environmental Policy – (PNMA), enacted by Federal Law 6938 on August 31, 1981. The act called for the creation of the National Council for the Environment (CONAMA), which acts as a consulting agency and regulatory body responsible for environmental regulation improvement. Federal environmental legislation falls under the jurisdiction of the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), whose role includes environmental licensing for any projects considered under federal responsibility. Each state also has a regulatory agency that handles the environmental licensing process for projects considered under their jurisdiction.

Environmental licensing in Brazil is a three-step process. The first step is to obtain a Preliminary License. To acquire the Preliminary License, an EIA/EIS must be submitted to the state, and occasionally federal, environmental regulatory agency, which then makes the EIA/EIS available to the public for review. This is done in accordance with provisions made by CONAMA. As a second step, a public hearing is held so communities have the opportunity to express their concerns and expectations, prior to decision making on whether or not to grant a license. The next step includes acquisition of an Installation License (LI) and an Operation License (LO), which have varying application requirements, depending on the type of project. In accordance with CONAMA legislation (Resolution 6/87) for Power Generation Projects, an Environmental Management Plan (Projeto Básico Ambiental – PBA) is also required, which corresponds to an EMP. To obtain an Operation License, a technical report presenting records of compliance with LI conditions is required, in addition to an inspection of the constructed facilities by an environmental agency to check for conformity with the construction design submitted and environmental programs and measures outlined in the EMP.

The environmental permitting process for the Macaé Merchant Power Plant is handled by the State Secretary for the Environment of Rio de Janeiro (SEMADS <sup>(1)</sup>). The State Foundation for Environmental Engineering (FEEMA <sup>(4)</sup>) is the technical body that works under SEMADS and manages the state permitting process. FEEMA reviews all environmental license applications and technical documents (e.g. EIA/EIS, EMP, and LO

applications) and submits technical appraisals to the State Commission of Environmental Control (CECA <sup>(2)</sup>). CECA serves as a regulatory body at the state level. It is composed of representatives from several state agencies and is presided over by the State Environmental Secretary. Once CECA makes a decision to grant a license, FEEMA is authorized to then issue the license to the company soliciting it.

All specific procedures for environmental permitting in the state of Rio de Janeiro are determined by the System of Licensing for Polluting Activities (SLAP). According to SLAP requirements, CECA is entitled to exercise policing powers required to control pollution and provide environmental protection, while FEEMA is the technical body responsible for implementing SLAP, by monitoring environmental quality.



Two other relevant agencies under SEMADS are SERLA and IEF <sup>(3)</sup>. SERLA <sup>(5)</sup> is the State Superintendent for Rivers and Lakes (or the state water agency) and is responsible for technical decisions related to the use of water from state rivers. IEF, on the other hand, is the department responsible for implementing state forestry policy. IEF supervises parks and forests for the state of Rio de Janeiro and manages conservation units and tree nurseries, as well as carries out other related functions.

- **World Bank / IFC safeguard policies and environmental, health and safety guidelines**

The following IFC regulations apply to the Macaé Merchant Power Project:

- Environmental Assessment – (OP 4.01);
- Natural Habitats – (OP 4.04);
- Cultural Property – (OPN 11.03);
- Involuntary Resettlement – (OD 4.30);
- Pest Management – (OP 4.09)

As standard corporate practice, El Paso, as project developer, strictly complies with laws governing “Forced Labor and Harmful Child Labor practices”.

Full compliance of the project with World Bank/IFC safeguard policies and environmental, health and safety guidelines is demonstrated in the following sections of this executive summary.

#### 4. **Baseline Data**

- **Biophysical**

The municipality of Macaé is almost entirely located within the Macaé River basin, which comprises a dense drainage network located within a wet tropical region. The climate of Macaé is classified as sub-tropical, with moderate humidity, dry winter and wet summer.

The Macaé River serves as the water supply source for the towns of Macaé, Rio das Ostras, and the community of Barra de São João. The river also supplies water for industrial uses.

The Macaé River shapes a large alluvial plain, filled with sediments, mainly gravel, sand and unconsolidated silt.

Two different types of forests comprise the Macaé River basin. The first type is the seasonal semi-deciduous forest, located on lowlands, closer to the coast. In the past, sugar cane plantations took over most of the forest. Today, the countryside in the low lands of Macaé River basin is mostly grassland and is used for cattle raising. The second type of forest is a dense ombrophylous forest found at the higher part of the river basin. This forest is still reasonably preserved throughout the Serra do Mar mountains ridge. This coastal area has pioneer formations under marine influence (coastal forests or “restingas”).

Mangroves are only found at the estuary of the Macaé River and grow on muddy sediments, which are influenced by tides. The mangroves have been recently threatened by their proximity to squatter communities, which are settling on the bank of the river on the opposite side of the mangroves.

One of the banks of the Macaé River forms a peninsula-like sandbar (*restinga*). Flooded fields and coastal forests cover the sandbar. The quaternary plain located northwest of the sandbar (partially protected by the National Park of Restinga de Jurubatiba) includes both herbaceous and arboreal (forests) plant species.

In the fields surrounding the area, several species of birds, such as hawks, owls and vultures are present. Mammals are less often observed in this area and the most common species are small rodents. Most of the fauna in the coastal forests is represented by species observed in the Atlantic Rainforest. The only exception appears to be the bird species “sabiá-da-praia”, often caught and kept captive for its ability to imitate several sounds.

There are three conservation units within the studied area. The first unit is the National Park of Restinga de Jurubatiba, located 19 Kilometers from the project site. It was created in April 1998 and has an area of 14,860 hectares. The park runs along the state coastline, passing through the towns of Carapebus, Macaé and Quissamã. The second conservation unit, the Biological Reserve Fazenda União, was created in April 1998 and is aimed at ensuring the protection, conservation, and recovery of the Atlantic Rainforest and associated formations and fauna, especially the mico-leão-dourado (*Leontopithecus Rosalia*). The reserve is located 18 kilometers from the project site. The Atalaia Municipal Park is the third conservation unit and was created in June 1995. The park comprises a total area of 235 hectares and preserves portions of the Atlantic Rainforest. The park is located approximately 13 kilometers from the Macaé project site.

- **Socio-economic**

The municipality of Macaé includes an area of 1,218.8 km<sup>2</sup> and has a population of approximately 115,000 inhabitants (1998). Sugar cane production used to serve as the basis of the Macaé economy. Once Petrobras built the Cabiunas Station in 1978, the town's economy became primarily industrial, commercial and service oriented and there was an increase in migration to the city by people seeking better employment opportunities. The expansion of the oil industry in the area generated over 7,200 direct jobs and 14,000 indirect ones. According to data provided by the Macaé City Treasury Department, tax and royalties resulting from oil and gas production activities grew by over 100% between 1995 and 1999.

The first Development Plan for the city of Macaé was done in 1979. The plan was developed in response to the rapid population growth and uncontrolled urban expansion resulting from the new employment opportunities created by the installation of the Cabiunas Station (Petrobras). Three new plans were proposed or reviewed from 1980 through 1989,

addressing issues related to municipal zoning, demarcation of city limits to a land distribution law, and to impact assessments done in the region. These plans were never approved by the city government, but did form the basis of a Municipal Master Plan for Macaé (1990), which serves as the only urban plan presently used by the city.

Currently, the most important resource in the Macaé region is petroleum, which is explored in offshore fields at Campos Basin. Approximately 83% of Brazil's proven oil reserves and 41% of Brazil's natural gas reserves are concentrated in this area.

Expected investments for the municipality over the next 5 years are over R\$ 10 billion. The types of services and industry will diversify creating new economic activities in the region, such as: lodging, catering, drilling companies, industrial assembly, heavy-duty mechanical services, transportation services and suppliers for offshore facilities.

Changes in the economy can already be observed in the tertiary sector that represents 41% of the municipal labor, while the secondary and primary sectors are represented only 8% and 4%, respectively. In the primary sector, cattle raising continues to represent 40% of the area's industry and the Macaé region is considered the third largest producer of cattle in the state of Rio de Janeiro.

Domestic sewage from the city of Macaé and outlying rural settlements is frequently disposed into the Macaé River. In the country, the effluents disposed are mainly generated by agricultural activities, such as sugar cane farms and cattle ranches. This issue is currently under environmental focus by the state and local regulatory agencies and the municipal government as they seek solutions to this problem.

## 5. Environmental impacts

- **Biophysical**

- (i) **Air Quality**

- **Stack emissions, air quality impacts, impacts on ecologically sensitive areas**

- Based on an analysis performed (results summarized below), Macaé Merchant emission rates comply with World Bank guidelines. The combined operations of Macaé Merchant and UTE Norte Fluminense, even considering future possible high-level NO<sub>2</sub> background concentrations, will not lead to violations of either Brazilian legal limits or World Bank guidelines for air quality. Though previous ISC runs for atmospheric dispersion have considered PM and SO<sub>2</sub>, the present report focuses on NO<sub>2</sub>, since it is widely acknowledged as the critical pollutant from natural gas driven power plants.

- **Greenhouse gas emissions assessment**

- Assuming that the Macaé Merchant Plant operates at 40% capacity factor (3,000 GWh/year), at an average thermal efficiency of 35% in a simple cycle regime, the plant is expected to consume around 1 billion m<sup>3</sup> of gas per year, emitting about 1.8 million metric tons of CO<sub>2</sub> per year (using USEPA AP-42 current emission factor of 110 lb/MMBtu heat input), equivalent to about 0.6% of Brazilian National CO<sub>2</sub> emissions in 1998 (295,86 million t-CO<sub>2</sub>/year). The capacity factor and emissions will of course vary depending on the wholesale electricity market.

**COMPLIANCE WITH WORLD BANK GROUP AIR EMISSIONS GUIDELINES**

POLLUTANTS	MACAÉ PROJECT	BRAZILIAN REQUIREMENTS	WORLD BANK ENVIRONMENTAL GUIDELINES	MITIGATION MEASURES
NOx	Up to 125.0 mg/Nm <sup>3</sup> (1)  61 ppm	Compliance evaluated by ambient air quality impacts – Res. CONAMA 03/90	125 mg/Nm <sup>3</sup> dry, 15 % O <sub>2</sub>  61 ppm	Water injection to control NOx emissions
Stack height	16.7m (2)	Not regulated	Good Engineering Practice	Not applicable

Notes: i. Dry volume, zero degree Celsius, 1 atmosphere, 15% O<sub>2</sub>; 12.5 g/s or 126.8 mg/Nm<sup>3</sup> without correction for actual water and O<sub>2</sub> content in the exhaust flow was conservatively used for simulation purposes instead of 12.3 g/s (equivalent to 125 mg/Nm<sup>3</sup> also without correcting for water and O<sub>2</sub> content, given Macaé Merchant exhaust flow temperature). El Paso is committed to operate the plant with emission rates below WB guidelines, but due to possible variations in the characteristics of the natural gas, it is not technically feasible to guarantee emission rates as per the GE specifications.

ii. Initially the layout for the plant called for stack bases placed 20 meters above sea level. The final engineering design placed the base of the stacks 30 meters above sea level, which reduced stack height from 20 to 16.7 meters, without compromising good engineering practices.

**COMPLIANCE WITH WORLD BANK GROUP AIR QUALITY GUIDELINES – NO<sub>2</sub> (µg/m<sup>3</sup>)**

NO <sub>2</sub>	BACKGROUND LEVEL WITHOUT PROJECTS (A)	INCREMENTAL IMPACTS BY MACAÉ 16 TG (B)	CUMULATIVE IMPACTS BY MACAÉ 20 TG AND NORTE FLUMINENSE (C)	RESULTANT LEVELS (A+C) (**)	BRAZILIAN AIR QUALITY STANDARDS CONAMA 03/90	WORLD BANK AIR QUALITY GUIDELINES (***)
1-h Average	Continuous measurement underway (*)	87.20	236.69	236.69	320	NR
Annual Average		2.13	4.3	4.3	100	100

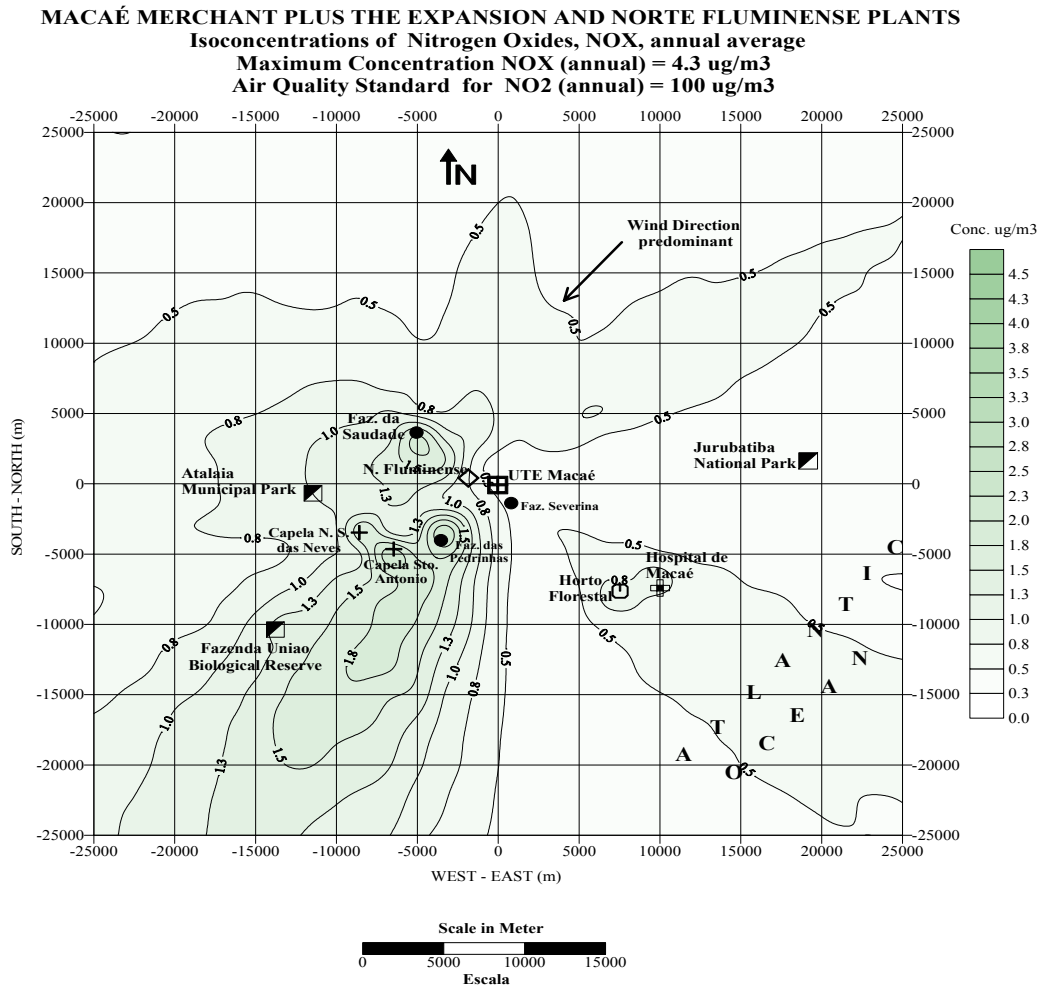
(\*) Typical unpolluted ambient air has 7.5 to 9.4 µg/m<sup>3</sup> (\*\*) Maximum ground level concentrations are estimated to occur at 9,3 Km, SW direction for 1-h Average, and at 5.5 km, SW direction for Annual Average. (\*\*\*) World Bank (WB) Group air quality guidelines are to be used in the absence of host country air quality standards. These are presented for reference only. WB guidelines do not include a one-hour limit for NO<sub>2</sub>. They do include, however, a 150-µg/m<sup>3</sup> limit for 24-hour averages. It is unlikely that Macaé Merchant and UTE Norte Fluminense would reach these levels of concentration.

**IMPACTS ON ECOLOGICALLY SENSITIVE AREAS (ANNUAL MEAN)**

	RESTINGA DE JURUBATIBA NATIONAL PARK	FAZENDA UNIAO BIOLOGICAL RESERVE	ATALAYA MUNICIPAL PARK	WORLD BANK GROUP GUIDELINES* (PSD INCREMENT FOR CLASS 1 AREAS)
Area	14,860 ha	3,126 ha	235 ha	
Distance from Macaé project	19 km	18 km	13 km	
Description	One of the most diverse of Brazil's coastal ecosystem.	Atlantic Forest	Atlantic Forest	
NO <sub>2</sub> incremental impacts by Macaé (Annual Mean)	Minimal (Less than 0.32 µg/m <sup>3</sup> )	Minimal (Less than 1.41µg/m <sup>3</sup> )	Minimal (Less than 1.02 µg/m <sup>3</sup> )	2.5 µg/m <sup>3</sup>

(\*) The World Bank guidelines do not include incremental limits for ecologically sensitive areas. A 2.5 µg/m<sup>3</sup> (Annual Mean) is used by US EPA for Class 1 PSD Increments (allowable increments to National Parks, etc.)

The results of annual average modeling for NO<sub>x</sub> emissions, considering the conservative figure of 12.5 g/s per CT as explained above, are presented for ground level concentrations in the NO<sub>2</sub> contour map below.



▪ **Water Injection**

The LM6000 units will operate under a single cycle, firing natural gas and using water injection for NO<sub>x</sub> abatement purposes. The NO<sub>x</sub> control will be performed within the combustion section of the turbine, by injecting demineralized water. The water will provide the reduction of the adiabatic flame temperature, minimizing the production of NO<sub>x</sub>. The water collected at the river will be clarified and demineralized before injection into the combustors of the turbine. This system will reduce the NO<sub>x</sub> emissions to a range of 60 ppm or less according to operational needs, consuming demineralized water at a rate from 1.05 kg/s through 1.63 kg/s per turbine, depending on the room temperature. Emission rate for NO<sub>x</sub> was considered in the EIA according to manufacturer specification for LM 6000 turbine (32 ppm). When assessing project expansion, a maximum emission rate of 61 ppm was considered as a worst-case scenario. Project commitment for NO<sub>x</sub> emission performance is to keep emission rates below 60 ppm.

▪ **Water supply availability**

The Macaé River has a minimum flow ( $Q_{7-10}$ ) of 4870 l/s. The 870 MW plant will take water from the river at a maximum of 86 l/s including water injection use, minus 2% of the minimum flow.

▪ **R-123 use**

The plant will use chillers to cool the inlet air of gas turbines to improve thermal efficiency. The chillers use R123 as cooling media for a Montreal Protocol regulated substance. The chillers recently received the US EPA Climate Protection Award due to the high efficiency and low emission features.

**(ii) Water supply and discharge**

▪ **Water demands and supply**

The Macaé Merchant plant will use a closed system with cooling towers. Consequently, a maximum flow of 86 l/s will be taken from the Macaé River. The minimum Q7-10 river flow rate is 4,870 l/s, according to data from the "CEDAE Master Plan for Water Supply of the Lakes Region, Macaé and Casimiro de Abreu". A return flow derived from the effluents of the demineralization process is planned, totaling 4 l/s, in addition to 8 l/s derived from the cooling cycle. Therefore, the total flow that will return after treatment to the Macaé River will be 12 l/s. The water intake design was submitted to SERLA and approved for the total authorized intake flow of 86 l/s. For safety purposes, the project design includes two water pumps (one for stand by) with a capacity of up to 100 l/s each.

The addition of four extra units to the project (for expansion to 870 MW) does not imply an increase in water consumption or effluent generation as designed operation parameters were adjusted accordingly.

▪ **Water and Wastewater treatment plant**

The water supply system for the Macaé Merchant Power Plant includes the following processes: intake and transfer of untreated water, pre-treatment of raw water (clarification), and demineralization and treatment of effluents.

▪ **Clarification**

The untreated water pumped by the transfer pumps will feed the flocculator-clarifier, initially receiving injections of soda to adjust the pH to the ideal level for the flocculation process. Next, aluminum sulfate will be added as a flocculating agent to stimulate the flocculation and clarification process. Finally the water, already clarified by the flocculation-clarification process, will be disinfected using sodium hypochlorite. The addition of the chemical products will be controlled according to the condition of the raw water, to ensure that the residual aluminum in the flocculator-clarifier effluent is zero. The sludge accumulated in the flocculator-clarifier will be removed automatically by regular bottom discharges. The water processed in the flocculator-clarifier will then be treated by the filtering stage, which is the final section of pre-treatment, and then pumped to the clarified water reserve tank as a basic input for the following applications:

- Make-up for the losses in the cooling tower forming part of the water circulation system
- Production process for dematerialized water
- Backup for the Mulsyfire system
- Drinking water

The bottom effluent from the flocculator-clarifier is processed by the sludge filtering/concentration system. An overflow line will partially recover the liquids, leading them to the liquid effluent auxiliary tank. After the concentration stage, the portion of sludge remaining in the bottom of the concentrator is processed by a filter press, which recovers any liquids and discharges the solid portion to the external stockpile. This discharge will produce around 3 cubic meters of solid residue per day.

- **Demineralization**

The water for this stage of the treatment is provided by dematerialized pumps, with a standby capacity of 100%, with the suction side connected to the clarified water tank. The process is carried out as follows:

First Phase: Cation exchange - Extraction of CO<sub>2</sub>

The discharge flow from the demineralization pumps will be taken through adequate pumping lines to a vessel containing a bed of positive ion exchanger resin (cationic exchanger), with a standby capacity of 100%, where the following exchange reactions will occur.

The effluent from the cationic exchanger, which is acid, will be carried through ebonite-lined pipes to the conventional degassing towers, where the CO<sub>2</sub> will be extracted. This stage is applicable when the content of carbonate normally present in the natural water justifies it. At the end of this stage, the decationized water is stored in a transition tank (decationized water tank), to which the suction pipes of the auxiliary demineralization pumps will be connected, to supply the subsequent phases of the production process.

Second Phase: Anion exchange

The discharge flow from the auxiliary demineralization pump will be carried by process pipelines suitable for the acidic nature of the cationic effluent to a vessel containing a bed of negative ion exchanger resin (anionic exchanger), where the exchange reactions will occur.

The effluent from the anionic exchanger will then be dematerialized water, which in turn will be carried to the final stage of treatment to ensure absolute purity.

Third Phase: Final polishing

Final polishing will be achieved by ionic exchange, using mixed bed exchangers comprising a mixture of anionic, cationic and inert resins, with intermediate densities that optimize the resin separations for the regeneration operations in the beds. During this stage, ions that pass through the previous phases will be retained.

The effluent from the mixed bed type exchangers is carried to the dematerialized water tank. This tank will have a storage capacity at least sufficient for 12 hours of operation, based on the consumption of all turbines at the maximum consumption rate.

- **Regeneration of Ionic Exchangers**

The working cycle of the ionic exchangers will be supervised automatically and reactivation operations of the resin beds will be carried out when the exchange capacity is saturated. This state can be monitored according to the following variables:

- Monitoring the total flow of treated water at a level compatible with the conditions specified in the demineralization plant design
- Raising the pH of the effluent in the case of cationic type exchangers
- Raising the conductivity value of the effluent in the case of anionic exchangers and mixed beds

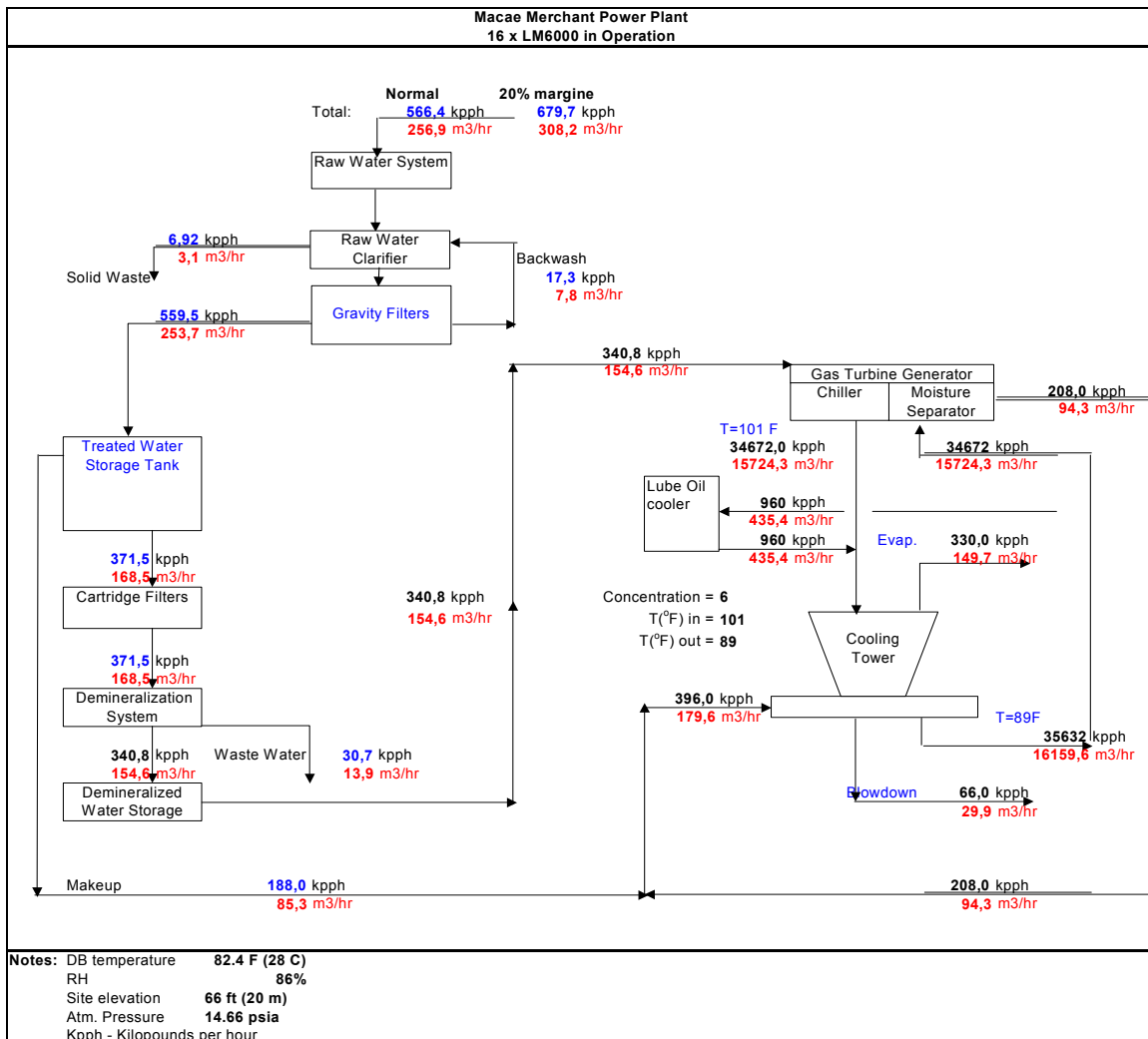
In these cases, limiting value monitors initiate the shutdown sequences of the depleted exchangers and activate the corresponding alarms, warning the operator to take the measures necessary to carry out the regeneration sequences on the depleted beds. The regeneration operations carried out are similar to those in the production process.

Effluents from the Regeneration Steps

The chemical effluents from the regeneration of the ionic resins, as well as all other effluents generated by processes involving chemical injections, such as from cleaning dosing tanks, will be routed through adequate lines to an effluent treatment tank, before their disposal.

▪ **Water balance (intake, water injection, cooling water make-up, etc.)**

The table below presents the balance of water uses on the various systems of Macaé Merchant Power Plant:



### LIQUID EFFLUENTS LIMITS AND APPLICABLE STANDARDS

PARAMETER	DISCHARGE FLOW	ART. 21 RES. CONAMA 20/86	FEEMA NT-202.R-10	WORLD BANK
PH	6 - 9	5 – 9	5 – 9	6-9
Temperature	< 40 °C	< 40°C increase at the edge of mixing zone < 3° C	< 40 °C increase at the edge of mixing zone < 3° C	increase at the edge of mixing zone < 3° C
Settling solids	< 1ml/l, Imhof test, 1 hour	< 1ml/l, Imhof test, 1 hour	NR	NR
Dissolved solids/solids in suspension	500/50	NR (ver art 23)	NR	NR / 50
Oil and Grease	10 mg/l	20 mg/l	20 mg/l	10 mg/l
Copper	0.5 mg/l	1.0 mg/l	0.5 mg/l	0.5 mg/l
Soluble iron	1 mg/l	15 mg/l	15 mg/l	1 mg/l
Total chromium	0.5 mg/l	0.5 mg/l CR6 2.0 mg/l Cr6	0.5 mg/l total	0.5 mg/l total
Zinc	1 mg/l	5 mg/l	1 mg/l	1 mg/l
Total heavy metals	10 mg/l	NR	NR	10 mg/l
Nitrates	10 mg/l	10	NR	NR
Sulfates	500 mg/l	NR	NR	NR
Phenolic substances C6H6OH	0.2 mg/l	0.5 mg/l	0.2 mg/l	0.5 mg/l
Phosphates (PO <sub>4</sub> )*	6 mg/l	NR	NR	6 mg/l
COD	150 mg/l	NR	150 mg/l	250 mg/l
BOD	15 mg/l	NR	>80% reduction	50 mg/l
Chlorides	750			
Chlorine (Residual)	0.2 mg/l	0.2 mg/l	0.2 mg/l	0.2 mg/l
Coliforms	400/100 ml	NR	Controle via DBO	400/100 ml

NR – not regulated

Note: Discharge parameters after treatment, considering the characteristics of the intake raw water and the chemical products to be used in water treatment, cooling tower and demineralization units; WB limits as per Pollution Abatement Handbook – Guidelines for New Thermal Power Plants and General Guidelines, Art 21, Res. CONAMA 20 or Art 23, Res. CONAMA 20 – and NT.202 R.10, FEEMA, RJ.

#### (iii) Noise

There are no residential receptors to be affected by plant noise. The closest residential receptors are located in the Santa Rita Ranch and are being relocated as described in the resettlement section of this document. All the families of the former ranch workers will be relocated, including both those who reside within the plot of ranch land purchased by El Paso, and those who reside outside of the purchased lot. After relocation of the 17 ranch families, the only receptors will be BR-101 road users.

Even though ranches and farms presently occupy the Macae plant area, the Municipality of Macaé granted both Macaé Merchant and Norte Fluminense Power Projects municipal land use in the Severina district, along the BR-101 federal road. The municipal government wants to create a new industrial zone to serve as an alternative to Cabiúnas Industrial Zone,

whose further growth is currently constrained by the presence of a national park and residential urban expansion. New receptors eventually installed in the area around the plant are likely to be industrial receptors since the area is no longer a residential zone and permits for housing in the area will no longer be granted.

The mathematical modeling used to test for noise impacts, considered a scenario in which both Macae Merchant and Norte Fluminense power plants would be operating at full capacity. Tests revealed in noise levels varying between 44 and 60 dB(A) along the major part of the Macae plant fence line. An exception was observed at the fence along the BR-101 road, where the measured background presented variation between 56 and 76 dB(A). At that point, the increase in the measured background caused by the two plants is less than 3 dB(A).

Those results are in compliance with World Bank limits for industrial receptors - 70 dB(a) or with the World Bank limits for increases in measured background – 3 dB(A). The noise test results are also in compliance with Brazilian standards regarding noise level limits for industrial receptors – 60 dB(A) by night and 70 dB(A) by day, as well as with the Brazilian standards for increases in measured background – 10 dB(A). There are no residential receptors in the vicinity of the plant who could be affected by noise in excess of World Bank residential noise guidelines (45 dB(A) night time, 55dB(A) day time).

**(iv) Solid waste**

The Macaé Merchant plant’s Water Treatment Station is programmed to treat up to 308 m<sup>3</sup>/h of water for refrigeration of the plant system and has other uses as well. The operation of a water treatment station generates solid residues, known as station sludge, classified by the ABNT as Class II waste (non-inert residues). This waste must be adequately disposed of in licensed Class II dumps. Around 3 m<sup>3</sup>/day of residues will be generated through the water treatment process. Other solid wastes include relatively small quantities of used lubricating oil and oil sludge from oil/water separation, filter cartridges, used resins (to be recycled by supplier) and common wastes, all of which will be handled, stored and disposed of in accordance with Brazilian regulations and World Bank guidelines to ensure the use of best methods and practices. Appropriate disposal of this waste will avoid water contamination and land pollution normally associated with the inadequate disposal of residues.

- **Socio-economic**

- i) **Land use change / resettlement**

- **Changes in the landscape**

The land selected for the plant site is located in a rural area. Ground elevation varies from 50 meters above sea level, at the top of scattered hills to 5 meters elevation in the plain areas along the riverbank. Earthwork done in constructing the plant reduced ground elevation to 30 meters. In addition to the main plant a smaller building was constructed for a water intake and pump station, at the bank of the Macaé River, 500 meters from the site entrance, at the opposite side of the BR-101 road. Landscaping is being done for that area to include revegetation along the riverbank. All remaining project structures are underground (gas pipeline and water pipeline) and do not significantly alter the landscape.

- **Land use change and resettlement**

Since the power plant project is located in a rural area of Macaé, its installation required changing the land use from rural to industrial. The future installation of a new thermal

power plant next to Macaé Merchant will contribute to this process as well. The Macaé administration has plans to change the formal designation of this area to an industrial zone in order to create an alternative to the Cabiunas industrial zone, which is being impacted by urban expansion. The presence of a gas pipeline in the region will stimulate industrial development in the nearby Severina district, as small and medium scale industries take advantage of the availability of gas.

- **Restriction of land use along gas pipeline right-of-way**

Use of land along the gas pipeline corridor will be restricted and no buildings will be permitted. Although the pipeline route does cross some cattle raising pastures, the pipeline will not affect them.

ii) **Local economic benefits (employment, services, industry)**

- **Employment generation during construction**

Labor demands frequently vary depending on construction and production levels and demand for specific skills. In general the maximum number of employees involved in plant construction at one time was approximately 1000. Employment of local man power reached approximately 80% of that total. Total wages paid out in the construction phase were on the order of R\$ 70 million.

As a priority, local labor was given employment preference. Many companies in the area provide construction and assembly services. As a result, the project attracted very little migration to the area by potential employees from outlying regions. This minimized potential social impacts on the community. Employees from other parts of Brazil or abroad were only hired to meet the demand for highly specialized labor for the electro-mechanical assembly of the plant.

- **Local income generation**

In addition to the direct demand for employment to support the Macaé Merchant plant construction and assembly, indirect employment opportunities have also been created by an increase in the demand for local goods and services. Macaé Merchant operations have increased the demand for food, goods and materials, lodging, and transportation, stimulating a boost in the local economy. An estimated tax benefit to the municipality was R\$ 7 million during construction.

- **Employment Generation during plant operations**

To run the power plant, employees will need to be hired in the civil, mechanical and electrical fields. Operation of the power plant should require a total of 50 permanent employees. Due to the small number of direct permanent jobs that the plant will be able to offer, social and demographic impacts at the operational stage of the project will be minimal. However, El Paso implemented a recruitment program, which includes supporting professional training programs to better prepare workers to compete for available positions and improve their technical skills for future opportunities.

iii) **Improvement of electricity supply / cost to the region**

The Northern part of Rio de Janeiro state lacks a reliable power supply system. This is due to the poor condition of the interconnected S/SE/CO electricity network. Prior to the Macaé Merchant plant, no power plants existed in this portion of the electricity network to meet the power needs of this area of the state. Macaé Merchant Power Plant is the first energy generation project to be installed within the branch of the electricity system that serves the

region. Presently, the region relies solely on energy imported from other sectors of the electricity network.

There is an increasing demand for services created by the expansion of the oil and gas industry. A reliable electricity supply will help support further development in the area.

## 6. Analysis of Alternatives

### Site Selection

Three areas were evaluated prior to selecting the site for the Macaé Merchant Power Plant. These included: two in the municipality of Macaé (the Cabiúnas and Severina sites) and the last in the municipality of Campos dos Goitacazes (the Campos site). The Campos site was eliminated as an unfeasible option because the gas pipeline was located 90 kilometers away and there were possible land use conflicts with neighboring residents.

Initially, El Paso had selected the Cabiúnas site with around 60 hectares, because it met technical conditions for construction and was in close proximity the Petrobras installations, which will supply the gas for the plant. This site, located at the industrial area in the municipality of Macaé, was purchased in 1997, one-year before the creation of the Restinga de Jurubatiba National Park, which is located approximately two kilometers from Cabiunas. The creation of the national park became a deterrent in selecting Cabiunas as a power plant site, because of potential impacts and El Paso's commitment to ecological preservation. El Paso therefore re-evaluated the feasibility of constructing the plant at the Cabiúnas site and decided to purchase another area of land (around 100 hectares) also in Macae, and called it the Severina site. This site then became the preferred location for the project and the plant was developed on this site.

Comparison of the site alternatives analyzed is presented in the table below:

**SITE ALTERNATIVE ANALYSIS**

<b>SITE FACTORS CONSIDERED</b>	<b>CABIÚNAS</b>	<b>SEVERINA</b>	<b>CAMPOS</b>
Access	Amaral Peixoto Highway (RJ-106)	BR-101 Highway	Campos - Itaperuna Road
Earthmoving Soil Volumes	Lower requirements	Greater requirements	Lower requirements
Geotechnical	No geotechnical problems	No geotechnical problems	Need for geotechnical investigations
Flooding	Area above flood level	Area above flood level	Area above flood level
Water Source	Rio Macaé - 15km; Underground water: under ongoing evaluation	Rio Macaé - 0.5km	Rio Paraíba do Sul
Transmission Line			
Distance TL 345kV	10 to 12km	0.3km	Less than 1km
FURNAS Transmission Capacity	YES	YES	YES
Natural gas Distance to the closest source.	0.8 to 1.0 km (from Cabiunas)	11km (from GASDUC existing city gate)	Approximately 90 km from Cabiunas station
Need for Resettlement	Already designated as an industrial area.	17 families likely to be economically affected	Possible need to purchase additional land from neighboring landowners.

SITE FACTORS CONSIDERED	CABIÚNAS	SEVERINA	CAMPOS
Conservation Unit	2 km from Restinga de Jurubatiba National Park	None	None
Gas Pipeline	Pipeline crosses an industrial area, between the PETROBRÁS Cabiúnas Station and the site	From PETROBRÁS valve yard, crosses a rural area with pastures.	Need for a gas pipeline from Cabiúnas to Campos (approx. 90km)
Air Quality Standards	CONAMA Resolution 13 /89 defines the maintenance of air quality over conservation units (Class I conditions)	CONAMA Resolution 03/90	CONAMA Resolution 03/90
Atmospheric Emissions Existing industries	<ul style="list-style-type: none"> <li>Cabiúnas Station</li> <li>Refilling of gas bottles</li> </ul>	There are no industries in the area.	Campos Power Plant
Atmospheric Emissions Future industries	<ul style="list-style-type: none"> <li>Expansion of the Cabiúnas Station</li> <li>Power plant already licensed</li> <li>Power plant being licensed</li> <li>Future industries</li> </ul>	Power plant being licensed	No new industries planned.
Land Use Zoning (Municipal Law 1.683/96)	Industrial Zone	Rural Zone	Industrial Zone
Land Use and Vegetation Sites	Totally anthropic characteristics, with pasture vegetation	Totally anthropic characteristics, with pasture vegetation	Urban area with real estate development around it
Land Use and Vegetation Cover Site's surrounding areas	<ul style="list-style-type: none"> <li>Located in an industrial area in Macaé, approx. 1.5 km from residential building area</li> <li>2 km from the Restinga de Jurubatiba National Park</li> <li>Close to the Cabiúnas sand pit area.</li> </ul>	Located in a rural area, characterized large pastures.	Campos Substation. Urban real estate developments
Urban Concentrations: Proximity	Approx. 1.5 km from the closest urban area	Approx. 11 km from the closest urban area	Located in urban area
Liquid Effluents Discharge location	Pumped to the Jurumirim channel, flowing into the left bank of the Macaé river, located approx. 3.5 km from the site; discharge in the sea or lakes were not considered	Discharge into the Macaé river, upstream of the intake	Discharge on the left bank of the Paraíba do Sul river, upstream of the municipal water company intake
Possible Local Impacts	Cumulative atmospheric emissions at region's conservations unities/Urban expansion in the surrounding area of the PPT/ Interface with lake system if underground water is used	Cumulative effect of atmospheric emissions with proposed neighboring power plant, but without affecting conservation units or urban areas	Cumulative effect of atmospheric emissions with Campos power plant, which could affect urban areas

## Technology Selection

The Macae Merchant Plant was built to operate as a merchant plant. The plant is only expected to run if either: (i) spot market prices are above a minimum level; or (ii) the regional electricity grid in the Rio-Espirito Santo area is capacity constrained (or technically unstable) and, as such, the system operator requests the plant to dispatch so as to reinforce the operation of the grid. Given the predominance of hydropower in Brazil, this operating regime is considered appropriate in that the plant is not expected to be dispatched when there is sufficient water in the country's reservoirs to meet peak demand. The plant's fuel supply arrangements and technology were developed in order to optimize the plant's flexibility so that it can effectively operate in the above manner.

In terms of technology choice, the Company decided to install 20 GE LM6000 engines operating in a single cycle mode for the following reasons:

- This equipment is extremely flexible and will allow the Company to meet the needs of the regional electricity system in an effective and efficient manner.
- The LM6000 engine is a unit with quick start-up capabilities and low start-up costs. These are important factors for a plant with expected daily start and stop operating characteristics.
- The selected technology is capable of dispatching efficiently in steps of 44 MW up to the maximum capacity of 870 MW. A combined cycle plant with the same output would have both a significantly reduced efficiency and a less attractive environmental performance if it had to operate at partial loads and with repeated starts and stops.
- The LM6000 engine is the most efficient gas turbine in its size range (40-70 MW), which has the environmental benefit of lower NO<sub>2</sub> and CO emissions as compared to other single cycle engines.
- Because of the energy crisis in Brazil and the resulting government-mandated electricity-rationing program, a high premium was placed by all parties on the fast-track implementation of the project. In this regard, the chosen technology could be placed in operation much more quickly than could a typical combined cycle technology. Macae's actual fast-track implementation timeline has borne this choice out.

## Expected Role of Macaé under the Priority Thermal Power Program

The Macaé Merchant project is part of Electrobras' ten-year Power Sector Expansion Plan (2000-2009). The program has been designated a priority project by the Brazilian government in response to a short term goal (2000-2005) of dramatically increasing energy generation capacity in the Southeastern region of Brazil by building thermal power plants to meet the growing energy demands in the area. The Macaé Merchant Project is considered an emergency project within the Priority Program for Thermal Power Plants (PPT) and falls within the government's plan for the power sector by:

- Diversifying the generation sources in the national power configuration, to reduce disadvantages of relying almost totally on hydropower generation (current scenario).
- Strengthening the generation capacity within the Southeastern region, which draws its energy from the Southern/Southeastern/Mid-Western interconnected electricity system, which is primarily supplied by hydropower.

## 7. Environmental Action Plan

### • Environmental Management System

The Environmental Management System (EMS) developed for the Macaé Merchant Project consists of environmental impact mitigation programs, monitoring, and quality control programs. Specific procedures have been developed to more effectively manage the tracking of environmental licenses, regulations, non-compliance issues, as well as to take necessary preventive mitigation and repair measures. The EMS has been designed based on ISO 14000 standards, which serve as international environmental management standards. The EMS outlines an organizational structure, duties, methods, procedures and resources to ensure the effective environmental management of power plants from the site assessment to the operations phase. Organizational structure and management responsibilities for the EMS were based on the Environmental Management Plan (EMP) for the Macaé Merchant Power Plant.

In order to effectively implement the EMS, an organizational structure was created to provide maximum supervision and monitoring, as well involve professionals from various sectors of the plant operations. An Environmental Supervision Unit, consisting of a team of representatives from plant operations, corporate communications, and the environment, health, and safety department, will be assigned to oversee the entire EMS implementation, training, and operation processes.

An Environmental Supervisor will be assigned to perform all technical functions including day-to-day monitoring, quality inspections and audits, and EMS training and trouble-shooting. The Environmental Supervisor will regularly meet with the Environmental Supervision Unit to provide status reports and to receive the input necessary to continually improve and update the EMS. The supervisor will be also responsible for keeping the Environmental Regulatory Agency informed about EMS results and regularly provide the agency with data generated by the system.

The EMS also calls for a Social Communication Program, which is designed to maintain an ongoing, pro-active public consultation process and strengthen community relationships by addressing public concerns and questions as they arise. Through the social communication program, every attempt will be made to keep the public informed about Macaé Merchant's environmental and social programs and their developments. El Paso has a permanent staff of communications professionals who will carry out the social communication function.

### • Environmental Mitigation During Plant Design

#### **Water Injection Process**

A water injection system was added to the turbine to reduce NO<sub>x</sub> emissions. The demineralized water is injected into the combustion chamber through ports in the fuel nozzles to reduce NO<sub>x</sub> production.

#### **Inlet Air Cooling System**

A gas turbine air inlet cooling system was also included in the design. This system optimizes turbine output and improves the turbine fuel efficiency when ambient temperatures are above 42°F (5°C). According to the Environmental Protection Agency (EPA) from the United States this chiller uses an “environmentally balanced alternative refrigerant and leads the industry with superior performance, boasting efficiencies of 0.48 kilowatts per ton or better at ARI rated conditions and a “near zero” refrigerant leak rate level. Performance exceeds all other product technologies currently in the marketplace, typically by 5 to 20 percent.”

#### **Purchase of additional land**

To minimize any potential impacts from noise, El Paso decided to purchase additional land to extend plant site boundaries and create a larger buffer zone surrounding the plant area.

- **Environmental Mitigation Programs**

**Environmental Construction Plan**

In order to reduce the impacts from plant construction, procedures were established for each construction stage to include, for example: prevention and control of possible spillage of pollutants; guidance and management of solid and liquid wastes; standardization of vehicle lubrication and refueling systems; and establishment of environmental protection and technical criteria to be used throughout construction. The Environmental Construction Plan also focused on training the construction workers by increasing their awareness of the importance of protecting flora and fauna and encouraging them to be pro-active in mitigating potential impacts of any kind during construction.

**Landscaping Plan**

The landscape plan includes re-vegetation of areas along the Macaé riverbank, as well as the planting of trees around the plant grounds. The aim of the plan is to beautify the area by making the plant grounds as green as possible.

**Social Communication Program**

A social communication program is in place to closely monitor public opinion and insure that any concerns are expressed and addressed. Through the program, surrounding communities are fully informed about plant construction and operations issues, which may affect them in any way, including employment opportunities.

**Hiring and Dismissal Program**

The goal of this program is to minimize any potential negative impacts resulting from the dismissal of employees who were hired to work only during the project's construction phase by providing additional training to help workers increase their employability. The training has helped construction workers make smoother transitions to other jobs in plant construction, since the Macaé area has a large gas and oil industry. El Paso also gives priority to local hires and guarantees employment training.

**Risk Management Program**

The risk management program is designed to prevent potential accidents and risks and to provide a plan of action in the event of an emergency. A risk analysis for the plant was done and is continually updated as means to anticipate and reduce potential accidents through effective communication with and training of plant personnel. The risk management program also includes an emergency response plan, which indicates what should be done and who should be contacted in the event of an emergency.

- **Environmental Monitoring Programs**

**Water**

Water quality in the Macaé River is monitored daily, weekly, monthly, and quarterly. The water is sampled and analyzed using physical, chemical, and biological parameters, in accordance with Brazilian standards and Standard Methods for the Examination of Water Wastewater (AWWA). The parameters are monitored during plant construction and operations include: turbidity; PH; sample temperature; air temperature; total suspended solids; total solids; oil and grease; dissolved oxygen; color; BOD; Al; Fe; HCO<sub>3</sub>; CO<sub>3</sub>; Cl; SO<sub>4</sub>; NO<sub>3</sub>; SiO<sub>2</sub>; NH<sub>4</sub>; Ca; Mg; Na; K; PO<sub>4</sub>.

**Air**

Air emissions in the stacks are monitored by Continuous Emission Monitoring System (CEMS). Stack emissions are double-checked manually according to an air quality-testing program approved by the state environmental regulatory agency. The parameters monitored are: NO<sub>x</sub>, CO, PM, PM<sub>10</sub>, CO<sub>2</sub> and O<sub>2</sub>.

Ambient air quality is monitored using an air quality and meteorological monitoring station located within the plant site. An additional station will be placed in the city of Macaé. Results are sent in real time to the state air quality department. The parameters monitored are: NO<sub>x</sub>, O<sub>3</sub>, THC and CO.

### **Noise**

Noise levels have been proven to be within state and federal requirements, even at the plant site boundary for ranch farms/industrial areas. Once all 20 turbines are in full operation, a noise performance test will be conducted to assure compliance with World Bank guidelines for noise limits. Noise measurements will be taken twice a year at the plant site, at the plant boundary, and at the nearest receptor locations. Noise measurements will include noise level (dB(A)), duration, statistical distribution for variable noise levels, noise source operations conditions, and meteorological characteristics during noise measurements. As an additional noise precaution, El Paso bought 200 extra hectares of land to create a noise buffer zone around the plant.

### **Effluents**

In addition to river water quality monitoring, as described above, the Environmental Action Plan calls for monitoring of the liquid effluents from the plant prior discharging the water in the river. Liquid effluents from industrial and sanitary treatments are being monitored for compliance with regulations. The following parameters are monitored: PH, temperature; conductivity; chlorides, settled, sediments, total non-filterable residues, volatile, non-filterable residues, dissolved oxygen, oil and grease, BOD (affluent/effluent), COD (affluent/effluent), metals, phenol index, phenol, sulfides, fluorides, sulfate, surfactant substances, residual chlorine, ammonium nitrogen, nitrogen and nitrite, total nitrogen, total phosphorus, toxic organic compounds, toxicity, fecal coliforms, and a number of samples in continuous effluents.

### **Solid Waste**

A solid waste management program is being implemented at the site to ensure appropriate handling, storage, and disposal of waste generated by all facilities. Solid waste, such as sludge and oil filters, will be transported and disposed of by licensed waste management companies. All the mandatory registration and notification procedures will be monitored and updated periodically to assure full compliance with FEEMA's requirements for solid waste management.

### **Underground Water**

The program is designed to control and prevent the contamination of soil and groundwater near storage or chemical handling areas, such as those close to warehouses, water and effluent treatment plants, etc. Soil and underground water samples from the targeted area will be regularly collected and tested for oil and contaminants. The program is part of the oil spill prevention program and the general contingency plan, which fall under the Environmental Management System.

### **Erosion Control**

During plant construction, specific measures were taken to prevent erosion. An erosion control program will be implemented to maintain existing measures and avoid future erosion. Routine monthly inspections of the area are carried out to monitor erosion.

- **Environmental Compensation Programs**

The project is in compliance with the Brazilian Federal Law # 9985 (July 18, 2000), requires that major projects, likely to produce environmental impacts, must invest an amount of at least 0.5% of its total cost in creating conservation units within the National System of Conservation Units (SNUC). A total of R\$8.4 million will be invested in compensation programs. This amount represents approximately 1% of the initial project investment of 400 million dollars.

Based on this amount, El Paso committed R\$ 5,000,000.00 to the development of the Desengano State Park. An additional R\$ 3.4 million was allocated to support other local environmental and social compensation projects in the region of Macaé.

The projects sponsored by El Paso for the Macaé Merchant Power Plant are described below and indicate the partners involved and the budget and estimated duration of each program.

### **Desengano State Park**

The goal is to improve the physical infrastructure of the park (e.g. trails, buildings, etc.) and create a management plan to better supervise park operations (e.g. planning, forest fire prevention and environmental education programs, etc.). The total project value is R\$ 5,000,000.00. The project implementation period is 36 months. The State Forestry Institute and the NGO, National Foundation for Nature Conservation (FBCN) are partners in the development of this project.

### **Macaé Canal**

A structure will be built along the bank of a Macaé River canal branch to promote the environmental recovery and protect a preserved mangrove from urban settlement. Total project value R\$ 1,500,000.00. The canal project is to be concluded in 12 months and is being developed in partnership with the municipality of Macaé.

### **Macaé River Reforestation**

The project focuses on reforestation of native species along the banks of the Macaé River basin.

Water Resources in Macaé River Basin The total project value is R\$ 1,250,000.00 to be invested over an 18-month period. The reforestation project is being carried out in partnership with the State Forestry Institute (IEF) and the NGO, Viva Rio.

### **Water Availability Assessment in Macaé River Basin**

Studies will be done to identify existing users, evaluate future demands, and analyze water quality and quantity resources. The total project value is R\$ 270,000.00 to be invested over a 12-month period. The project is being developed in partnership with the Water State Agency (SERLA).

### **Underground River Resources**

Studies will be done to identify the potential availability of underground water in the basin of the Macaé River. The total project value is R\$ 180,000.00. The project is to be completed within 12 months and is being developed in partnership with the State Department of Mineral Resources (DRM).

### **Environmental Protection Area Plan**

Preparation of a master plan to make the mangroves located along the Macaé River estuary an environmentally protected area is one of the environmental projects planned. The total project value is R\$ 200,000.00 to be invested over 12 months. The municipality of Macaé is the project partner.

- **Community Development**

- **Resettlement Plan**

- When additional property for the Macaé Merchant Power Plant was purchased, a former landowner dismissed 15 workers of a ranch called Santa Rita and left their families without work and in poor housing conditions. With the objective of providing better living conditions and creating sustainable economic development for these displaced residents, El Paso decided to sponsor a voluntary resettlement project.

- **Environmental Education Program**

- The goal of this program is to raise the level of community awareness of the importance of general conservation (e.g. waste disposal and recycling) and the preservation of nearby mangroves. The total project value is R\$ 250,000.00 to be used over a 12-month period. The program is being developed in partnership with the municipality of Macaé and with the NGO, CIMA.

## 8. LAND ACQUISITION AND RESETTLEMENT

- **Land acquisition**

Land acquisition for Macaé Merchant Power Plant involved the following:

**Acquisition of plant site – 1,012,190 m<sup>2</sup>** - Site acquisition for the power plant took place through a common business transaction between the rightful owner and El Paso. The Owner was represented by Arley A. Carvalho, who owned a larger farm called “Fazenda Severina”. A portion of 100 Hectares was negotiated for the plant on November 20, 2000.

**Acquisition of water intake area – 6,401 m<sup>2</sup>** - This land was also acquired from Arley A. Carvalho and was also part of “Fazenda Severina”. Transaction was made on February 2, 2001.

**Acquisition of additional land – 2,000,000 m<sup>2</sup> of Santa Rita Ranch** - Site acquisition took place through a business transaction between a real estate company representing El Paso and Arley A. Carvalho, owner of “Fazenda Santa Rita”. A site is part of a larger property an negotiation was held on June 21, 2001.

**Acquisition of the right-of-way for gas pipeline – 8,450 meters** - For the construction of the lateral from Petrobras’ gas pipeline (Gasduc I and II) to the power plant, the pipeline right of way (ROW) passes through six (6) different properties. These properties are named (i) Fazenda Santa Rita, (ii) Fazenda Pau Ferro, (iii) Fazenda Pau Ferro Anexo, (iv) Fazenda São Bento, (v) Fazenda Morro Bonito and (vi) Fazenda São João. The purchase of these lands was directly negotiated with the individual owners.

**Acquisition of the right-of-way for the water pipeline** - No land purchase was required as water piping is located within the plant site.

**Acquisition of the right-of-way for the transmission line** - No land purchase was required along the right of way of the transmission line, because interconnections to the regional electricity transmission system are located within the plant site.

- **Resettlement Plan**

In acquiring additional land surrounding the plant site, a portion of land from a nearby ranch called *Santa Rita* was included in this purchase. The primary function of the Santa Rita Ranch was cattle-raising and the ranch owner employed 17 resident workers and their families to do the work involved.

Before finalizing the land purchase with El Paso, the ranch owner decided to stop raising cattle and dismissed his employees causing them to lose their jobs and be economically affected. The ranch owner also requested that the ranch workers vacate their residences. Although the former ranch employees had no legal rights to any part of the purchased property, El Paso, in line with its commitment to social responsibility, decided to develop a program to assist the ranch community and compensate for losses in employment and housing, while also taking the extra step of promoting the sustainable economic development of the community. El Paso initiated the program from the public consultation phase and is carrying out program implementation and monitoring.

The first step in developing this program involved extensive public consultation with the former ranch employees and their families. Several meetings were held with members of the ranch community in an effort to identify their needs and determine how a program could best meet these needs. From these community consultations, it became clear that the ranch community's needs could best be met through a resettlement program, which would involve the creation of an agricultural village. The resettlement program is being carried out in compliance with World Bank Operational Directive - OD 4.30 dated in July 1990).

The resettlement program serves nine families from the purchased portion of the land, as well as an additional six families, residing in an adjacent area of the ranch, which was not purchased by El Paso. The six additional families were included in the program upon the request of the other nine families who emphasized the importance of keeping the community together. A total of 38 adults and 23 children are expected to directly benefit from the resettlement program.

Eventually, as the resettlement project focuses on sustainable development, El Paso plans to transfer management and ownership of the village to the resettlement community.

The resettlement program is divided into three basic stages:

- Community needs assessment
- Architectural, planning, and construction projects required to create a farm village, with consideration of the perspectives and needs of the affected community
- Agricultural production and training projects aimed at promoting the self-sufficiency of the resettled families

## 9. PUBLIC CONSULTATION AND DISCLOSURE PLAN

The public consultation process benefited from a comprehensive process of local community consultation, which had recently been done for a power project similar to Macaé Merchant by another project developer. Consequently, El Paso was familiar with how the local community perceived projects of this nature, including community concerns and perceived benefits.

One of the concerns presented related to a local non-governmental organization that expressed clear opposition to having thermal power developments in the vicinity of the Jurubatiba National Park. Local environmentalists were concerned about the potential cumulative impact on air quality

from adding more industrial development to the Cabiunas Zone, just 2 kilometers from the park. In response, El Paso considered other site options and selected the location discussed above.

Copies of the EIA/RIMA for the selected site were initially submitted by El Paso to the state environmental regulatory agency (FEEMA), which in turn made the document available for public consultation. Copies of the studies were also supplied to local NGO's, interest groups, and the city government for review.

Between EIA submittal and the official public hearing, numerous meetings were held to discuss results from the environmental studies. Meetings were held with the Macae environmental officers, local NGOs, local authorities, the business community, trade associations, and local communities. Major concerns raised included waste management, effluents treatment, and use of water, earthwork volumes, and impact of air emissions. Local NGOs suggested the need for more in-depth studies on the water resources of the Macaé River to assist the water agency (SERLA) in the decision-making process on future concessions. Concern was also expressed in relation to the erosion and sedimentation of the Macaé River as a result of the degradation of the riverbanks. Another major issue had to do with the maximum use of local resources during plant construction and minimizing workers migration to the municipality.

On February 15, 2001 a mandatory Public Hearing was held on the process of environmental licensing of the Macaé Merchant power plant project. Community participation in the event was effective and their input was included in the specific requirements stipulated in the Preliminary License.

In accordance with procedures for the Public Hearing, the agency invites the public, stipulating that the time and place of the Public Hearing must be announced at least 15 days in advance, in mass-circulation newspapers. At the event, after detailed explanation by the developer of the technical details of the project, and by the environmental consultant of the environmental impacts and mitigation measures recommended, the public is invited to discuss matters of interest and state specific demands as to the environmental management of the project. These can also be drawn up and described in written documents to be sent to the environmental agency by the deadline it establishes at the hearing.

Socio-environmental questions raised by the community during the consultation process and Public Hearing was incorporated into the supervision, mitigation and environmental compensation programs of the Environmental Management Plan.

The public consultation process was equally important in defining the project's environmental compensation program. Programs proposed by local NGOs and the municipality was included in the compensation program. These included preserving the region's water resources as well as a reforestation program of the Macaé River.

Further meetings were held with the community after the Public Hearing in order to keep the communication and information channel open. Presentations were held for the Macaé community, at which all –environmental and social programs, construction progress, and stages of the compensation programs were presented.

Public consultation will be ongoing throughout project operations. Reports produced by the Environmentally Management System will be made available in the Macae Environmental Office for public review. A toll free telephone line has been made available for citizens to call and receive clarification on questions or concerns. The designated Environmental Supervisor for the Macae Plant will follow up all concerns and requests on. Periodic meetings will be held with local community groups to update them on the progress of the environmental and social compensation programs and elicit their input on the programs in progress. These meetings will be coordinated by under the social communication plan for the plant. The social communication specialist will

maintain close community ties to keep the community involved and committed to preserving the environment.

**10. Compliance with IFC Safeguard Policies and World Bank Environmental, Health and Safety Guidelines**

- **Compliance with Safeguard Policies**

**COMPLIANCE WITH IFC SAFEGUARD POLICIES**

IFC SAFEGUARD POLICIES		MAJOR ELEMENTS	MACAÉ PROJECT
1	Environmental Assessment (OP 4.01)	<ul style="list-style-type: none"> <li>• Environmental Impact Assessment by Independent EA experts</li> <li>• Public consultation and disclosure</li> </ul>	<ul style="list-style-type: none"> <li>• The EIA was prepared by Ecologus, an independent environmental consulting firm registered in the federal environmental agency – IBAMA and in the Regional Engineering Council – CREA;</li> <li>• The EA process was supported by comprehensive consultation and public disclosure through mandatory and voluntary events involving community, authorities, and NGO's at local and state levels as described in section 9.</li> </ul>
2	Natural Habitat (OP 4.04)	<ul style="list-style-type: none"> <li>• No significant conversion or degradation of critical natural habitats</li> </ul>	<ul style="list-style-type: none"> <li>• There are critical natural habitats within 20 km from the project site. However, the impacts on those habitats are negligible as demonstrated in section 5.</li> </ul>
3	Cultural Property (OPN 11.03)	<ul style="list-style-type: none"> <li>• No significant damage to non-replicable cultural property</li> </ul>	<ul style="list-style-type: none"> <li>• A previous assessment of archaeological potential of the area was performed during the EIA phase, and field excavations were carried out before gas pipeline construction. Therefore, it was concluded that there is no known cultural property within the project site or areas needed for associated facilities. Study results were submitted to National Institute of Historical and Artistic Patrimony (IPHAN). Report was approved. In case cultural property is found during construction or later during the operational phase, the company has a policy to protect and recover any remainder, according to applicable legislation.</li> </ul>
4	Pest Management	<ul style="list-style-type: none"> <li>• To avoid the use of banned substances for agricultural or public health purposes.</li> </ul>	<ul style="list-style-type: none"> <li>• Biological methods will be used to control pests.</li> </ul>
5	Involuntary Resettlement (OD 4.30)	<ul style="list-style-type: none"> <li>• The population displaced by a project receives benefits from it.</li> </ul>	<ul style="list-style-type: none"> <li>• Land acquisition for the site involved resettlement of 17 families. This resettlement was handled in accordance with OD 4.30 as described in section 8.</li> </ul>

IFC SAFEGUARD POLICIES		MAJOR ELEMENTS	MACAÉ PROJECT
6	Forced Labor and Harmful Child Labor (Policy Statement)	<ul style="list-style-type: none"> <li>No forced labor or harmful child labor</li> </ul>	<ul style="list-style-type: none"> <li>No forced labor is used during the life cycle of the project. The company has a written statement of its commitment in complying with such policy.</li> </ul>

### COMPLIANCE WITH WORLD BANK ENVIRONMENTAL, HEALTH AND SAFETY GUIDELINES

WORLD BANK ENVIRONMENTAL, HEALTH AND SAFETY GUIDELINES		MAJOR ELEMENTS	MACAÉ PROJECT
1	1998 Pollution Prevention and Abatement Handbook, World Bank Group "Thermal Power: Guidelines for new Plants"	<ul style="list-style-type: none"> <li>Evaluation of project alternatives (technologies, site, cooling system, etc.)</li> <li>Environmental assessment (including cumulative impacts)</li> <li>Emission guidelines (air, liquid effluent, noise)</li> <li>Monitoring and reporting</li> </ul>	<ul style="list-style-type: none"> <li>Evaluation of project alternatives and technology selection took into consideration the applicable WB guidelines as described in section 6</li> <li>Cumulative impacts regarding noise and air emission where assessed in the EIA as described in section 5</li> <li>Monitoring and report procedures proposed in the EIA and detailed in the EMP are incorporated as a commitment in the permitting process as described in the EAP section 7</li> </ul>
2	IFC General Health and Safety Guidelines	<ul style="list-style-type: none"> <li>Workplace management</li> <li>Health and Safety management</li> <li>Occupational health and safety monitoring</li> </ul>	<ul style="list-style-type: none"> <li>During construction a rigorous Environmental Health and Safety Plan has been implemented to guarantee compliance with both Brazilian (NRs from the Ministry for Labor) and WB guidelines concerning workplace noise, work in confined spaces, health-general, safety-general, drinking water, training, occupational health and safety monitoring, records keeping and reporting.</li> </ul>
3	IFC Environmental, Health and Safety Guidelines for Polychlorinated Biphenyls (PCBs)	<ul style="list-style-type: none"> <li>Guidelines for installment, maintenance and disposal of PCB transformers and PCB contaminated equipment</li> </ul>	<ul style="list-style-type: none"> <li>No PCBs will be used in the transformers on site. Brazil has actually banned the use of such.</li> </ul>
4	IFC Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution	<ul style="list-style-type: none"> <li>Right-of-Way alignment</li> <li>Ambient noise</li> <li>Health and safety guidelines</li> </ul>	<ul style="list-style-type: none"> <li>MACAE MERCHANT will not be responsible for transmission or distribution of energy, since it will deliver its production at a FURNAS sub-station located on the site.</li> </ul>
5	1998 Pollution Prevention and Abatement Handbook, World Bank Group "Oil and Gas Development (Onshore)"	<ul style="list-style-type: none"> <li>Emission guidelines</li> <li>Monitoring and reporting</li> </ul>	<ul style="list-style-type: none"> <li>The project will involve a 9 km connecting gas pipeline without pumping stations. Emissions from the heater equipment are negligible and likely to comply with applicable guidelines.</li> </ul>

## 11. Conclusion

Throughout the entire environmental assessment process for the Macaé Merchant Power Project, every effort was made to identify potential impacts and prevent, minimize or compensate for these impacts by using best practices and fully complying with Brazilian environmental laws and regulations as well as with applicable World Bank/IFC safeguard policies and environmental, health and safety guidelines.

El Paso has also made every attempt to fulfill its obligations as a social responsible company by disclosing its environmental practices and supporting sustainable development programs which focus on improving the quality of life of area communities.

**SECTION 1**

**INTRODUCTION**

## **SECTION 1**

### **INTRODUCTION**

This report has been prepared by El Paso Energy International of Brazil for its Macae Merchant Power Plant, located in the state of Rio de Janeiro, Brazil, as part due diligence requirements for financing by the International Finance Corporation (IFC), a member of the World Bank. This report provides a complete description of the environmental management and social development programs sponsored by El Paso as part of the Macae Merchant Project.

The Macae Merchant Plant was considered a fast track, emergency project due to a power shortage crisis in Brazil. The plant was originally planned to be a 700 MW project, and was later expanded to a generation capacity of 870 MW to better meet the energy needs in the state of Rio de Janeiro.

The project consists of 20 GE LM6000 Turbines, which operate in simple cycles. These turbines are considered the most efficient for the power range (40-70 MW) of the plant. Simple cycle turbines also have greater flexibility in meeting variability demands of the plant.

Construction of the initial 16 turbines for 700 MW is about to be completed, with some units already in operation. The expansion to 870 MW (with an additional 4 units) was initiated in February 2002 and substantial completion is expected to occur in June 2002.

The project was licensed by the state environmental regulatory agency (FEEMA) in compliance with all steps of the environmental permitting process. An initial Environmental Impact Statement (EIS) was prepared in October of 2000. Then, in

December 2001, a supplemental EIS was prepared for the plant expansion to 870 MW.

Additional sections to this report provide a reference resource for information on all aspects of the environmental and social programs sponsored by the Macaé Project including:

- Land Acquisition and Resettlement Plan
- Public Consultation and Disclosure Plan
- Compliance with IFC Safeguard Policies
- Compliance with World Bank Environmental, Health and Safety Guidelines
- Social Impact Assessment
- Technology Selection
- Impact Assessment of Ecologically Sensitive Areas
- Greenhouse Gas Emissions Assessment
- Archeology and Cultural Properties
- Environmental Compensation Programs
- Environmental Permits (Previous License, Installation License, Installation License for Earthwork, Operation License, Decree of Right to Use the Water Resource of the Macaé River, Notice for Project Modification).

## **SECTION 2**

# **LAND ACQUISITION AND RESETTLEMENT PLAN**

## SECTION 2

### PART 1: LAND ACQUISITION

Land acquisition for Macaé Merchant Power Plant involved the following:

**1. Acquisition of plant site – 1,012,190 m<sup>2</sup>**

Site acquisition for the power plant took place through a common business transaction between the rightful owner and El Paso. The Owner was represented by Arley A. Carvalho, who owned a larger farm called “Fazenda Severina”. A portion of 100 Hectares was negotiated for the plant on November 20, 2000.

**2. Acquisition of water intake area – 6,401 m<sup>2</sup>**

This land was also acquired from Arley A. Carvalho and was also part of “Fazenda Severina”. Transaction was made on February 2, 2001.

**3. Acquisition of additional land – 2,000,000 m<sup>2</sup> of Santa Rita Ranch**

Site acquisition took place through a business transaction between a real estate company representing El Paso and Arley A. Carvalho, owner of “Fazenda Santa Rita”. A site is part of a larger property an negotiation was held on June 21, 2001.

**4. Acquisition of the right-of-way for gas pipeline – 8,450 meters**

(see Figure 1 on page 16 at the end of this section)

For the construction of the lateral from Petrobras’ gas pipeline (Gasduc I and II) to the power plant, the pipeline right of way (ROW) passes through six (6) different properties. These properties are named (i) Fazenda Santa Rita, (ii)

Fazenda Pau Ferro, (iii) Fazenda Pau Ferro Anexo, (iv) Fazenda São Bento, (v) Fazenda Morro Bonito and (vi) Fazenda São João. The purchase of these lands was directly negotiated with the individual owners.

#### **5. Acquisition of the right-of-way for the water pipeline**

No land purchase was required as water piping is located within the plant site.

#### **6. Acquisition of the right-of-way for the transmission line**

No land purchase was required along the right of way of the transmission line, because interconnections to the regional electricity transmission system are located within the plant site.

## SECTION 2

### PART 2: RESETTLEMENT PLAN

#### RESETTLEMENT PROJECT FOR FORMER EMPLOYEES AND RESIDENTS OF SANTA RITA RANCH

##### 1. Background

In acquiring additional land surrounding the plant site, a portion of land from a nearby ranch called *Santa Rita* was included in this purchase. The primary function of the Santa Rita Ranch was cattle-raising and the ranch owner employed 17 resident workers and their families to do the work involved.

Before finalizing the land purchase with El Paso, the ranch owner decided to stop raising cattle and dismissed his employees causing them to lose their jobs and be economically affected. The ranch owner also requested that the ranch workers vacate their residences. Although the former ranch employees had no legal rights to any part of the purchased property, El Paso, in line with its commitment to social responsibility, decided to develop a program to assist the ranch community and compensate for losses in employment and housing, while also taking the extra step of promoting the sustainable economic development of the community. El Paso initiated the program from the public consultation phase and is carrying out program implementation and monitoring.

The first step in developing this program involved extensive public consultation with the former ranch employees and their families. Several meetings were held with members of the ranch community in an effort to identify their needs and determine how a program could best meet these needs. From these community consultations, it became clear that the ranch community's needs could best be met through a resettlement program, which would involve the creation of an agricultural

village. The resettlement program is being carried out in compliance with World Bank Operational Directive - OD 4.30 dated in July 1990).

The resettlement program serves nine families from the purchased portion of the land, as well as an additional six families, residing in an adjacent area of the ranch, which was not purchased by El Paso. The six additional families were included in the program upon the request of the other nine families who emphasized the importance of keeping the community together. A total of 38 adults and 23 children are expected to directly benefit from the resettlement program.

Eventually, as the resettlement project focuses on sustainable development, El Paso plans to transfer management and ownership of the village to the resettlement community.

## **2. Organizational Tasks**

The resettlement program is divided into three basic stages:

- Community needs assessment.
- Architectural, planning, and construction projects required to create a farm village, with consideration of the perspectives and needs of the affected community.
- Agricultural production and training projects aimed at promoting the self-sufficiency of the resettled families.

## **3. Needs Assessment Stage**

Various activities were carried out to effectively evaluate the characteristics of the targeted community. The evaluation assessing each member's education level, social-economic status and technical strengths, housing conditions, and concerns and life dreams.

The needs assessment confirmed that most members of the rural ranch community depend on their own agricultural production to live, while some of the family members had jobs in the town of Macae.

Most of the residents had experience in cattle raising, with some knowledge of subsistence farming. The women mostly did housework, but also kept vegetable gardens and raised chickens and pigs for their own consumption. Some residents were found to possess more specialized skills and experience like driving tractors, artificial insemination, and technical knowledge in agricultural areas. The majority of the residents, however, are farm workers with little to no technical experience of any kind.

Information gathered throughout the needs assessment phase was acquired through interviews, meetings, debates, and focus groups where various subjects were discussed and possibilities explored. This information formed the basis for the proposed compensation program and led to the conclusion that the formation of a farm village would be the best way to meet the needs of these residents.

To ensure smooth development of the resettlement project, the following additional activities were carried out:

- Identification of resident wants and needs.
- Photographs and a video of the area, along with an inventory of each residence and notes of needed improvements.
- Socio-economic survey of the community involved.
- Identification of local leaders.
- Selection of potential resettlement areas.

These studies provided a clearer profile of the group to be served and also clarified their expectations about the resettlement and their prospects for a better quality of life.

#### **4. Community Participation**

As mentioned above, community input was gathered through interviews, games, meetings, and focus groups. Meetings were held at the municipal school, which serves the children of the Santa Rita residents, and were normally very well attended.

The community's participation played a significant role in the selection of the resettlement area, design of the new residences, and identification of the farm equipment needed. This community input also served as the basis for development of the agricultural program. As the project developed, the community was also frequently consulted about the architectural designs for the various proposed houses and community buildings.

To encourage a clear understanding of the project, plans were complemented with two scale models, one of the residence area on a scale of 1:20, including furniture, and one of the whole resettlement project on a scale of 1:1000. This helped the residents visualize the plan and better understand the project components including: the residential area, a school, a public plaza, and special plots set aside for agricultural production. The presentation of the project components and models was a huge success. Residents demonstrated strong approval of the proposed program and the construction plan.

An additional advantage of the extensive number of community meetings was an observed increase in the integration between families and a strongly verbalized commitment to meeting program objectives as a united community.

##### **4.1 Land Selection**

As Indicated above, extensive consultation was done with the ranch community residents before and during land selection. The particular needs of each family were taken into consideration in determining area parameters.

The area purchased for resettlement was the community's preferred choice and was selected from among seven separate options offered to the residents. This process was preceded by a technical evaluation carried out by a team of architects and agronomy engineers, who cited areas that displayed the best conditions for living quarters and agricultural production.

The property purchased by El Paso is called "Fazenda dos Quarenta" and is located 18 kilometers from where the Santa Rita farmers currently live. It is 484,888 m<sup>2</sup> in area and is located near the BR-101 highway, where it crosses RJ-178. This will provide direct access to downtown Macae. The area's topography is smooth, with nearly 80% covered by grass.

## 4.2 Projects Design

The concept of the "agro-villa" serves as the foundation of the community-planning project. An "agro-villa" is defined as a rural settlement program in which residential and community service facilities are built, while also designating areas for agricultural production.

### 4.2.1 Area Division

Three different sectors were considered in dividing the area:

- Residential Area
- Agricultural Area
- Environmental Preservation Area
  
- **Residential Area**

The residential area proposed for the resettlement covers 40,872 m<sup>2</sup> and stretches along the property line parallel to the BR-101 highway. Houses will be built at an

average distance of 100 meters from the highway. A forest will be planted along the property line to muffle traffic noise from the highway.

The residential area is designed to provide essential infrastructure such as: a water supply network, a drainage system, and power and street lighting. The streets will be paved and planted with trees.

The design allows for:

- 15 private lots with an area of 1,650 m<sup>2</sup> each, where the houses and animal raising areas (for chickens and pigs) will be built.
- A 1,350 m<sup>2</sup> lot for a school.
- A 3,896 m<sup>2</sup> lot for the village square.
- A 1,650 m<sup>2</sup> lot for a community center.
- A 1,717 m<sup>2</sup> plot for a barn.

In general, internal roads and residential lots are designed to fit the sinuous topography of small natural ground elevations.

- **Agricultural Area**

The agricultural production area is 334,159 m<sup>2</sup> and was designed to allow for 60 plots of approximately 5,000 m<sup>2</sup> each to include:

- 15 irrigated plots for growing vegetables.
- 45 non-irrigated plot for growing fruit.

The area's uneven topography (slight rises, cut by depressions) was considered in designing the production area. The area was developed to guarantee approximate equity in the distribution of plots among the residents. Factors considered include:

topographical characteristics, production capacity, and distance from the residential/community area.

- **Environmental Preservation Area**

The environmental preservation area covers a total of 109,244 m<sup>2</sup> and is comprised of non-native vegetation and a stretch of stream that crosses the property. The preservation area corresponds to about 22.56% of the total property. The demarcation and preservation of these areas satisfy legal requirements, which state that 20% of the land from a project of this nature must be preserved.

#### **4.2.2 Land Distribution**

Each family served by the project will receive an area of 21,234 m<sup>2</sup> distributed as follows:

- A 1,650.00 m<sup>2</sup> lot, located in the residential area, with a house and facilities for raising chickens and pigs.
- 4 rural production plots, with a total area of 19,584 m<sup>2</sup>, situated in the agricultural production area. One plot is to be used for vegetables and three for the growing of fruit.

### **5. Architectural Projects**

- **Residences**

There are two types of residences to be built, one with two bedrooms and the other with three bedrooms. Houses were specifically designed to serve the needs of the residents.

Low cost expansion of smaller houses is allowed for because foundations will be built the same size, independent of the final size of the house. Houses will have bedrooms, a living room, a veranda, a kitchen, a wash area, a bathroom and an extra toilet in the living area. Dimensions are as follows:

- 2 bedrooms – Usable Area = 48.15 m<sup>2</sup> and Built Area = 52.59 m<sup>2</sup>
- 3 bedrooms – Usable Area = 57.51 m<sup>2</sup> and Built Area = 62.81 m<sup>2</sup>

All rooms were designed to allow for maximum comfort. During plan design, concern about guaranteeing a comfortable temperature in the houses was expressed. In response, the architects designed a two-level roof system, which allows for cross-circulation of air and avoids the formation of hot air masses inside the rooms.

#### • **School**

The school project was developed after consultation with the Education Department of the Municipality of Macaé, who supplied the plans of a standard model of rural schools, as traditionally built by the government.

The projected school will be built on an area of 257 m<sup>2</sup>. The school grounds will cover 1,350 m<sup>2</sup>. The Municipal Education Department requested that the future school be situated to allow easy access by neighbors, whose children would also attend the school.

The school building will be larger than the existing school at the Santa Rita Ranch, which has only a single classroom. The school plans allow for two classrooms, which can accommodate 22 students each. It also has two bathrooms, one male and one female, a kitchen and pantry for preparing meals and storing provisions, a multipurpose dining area, which can double as an extra classroom or a community center, an office with an exclusive bathroom for school administration, and a large covered patio for recess and recreation.

The School has one teacher who is employed by the city of Macae. It is the city's responsibility to supply school meals and to maintain the building. The cook that serves the school was paid by the former ranch owner and is now being paid by El Paso.

- **Village Square**

A tree-lined plaza situated next to the school, in an area of 3,896 m<sup>2</sup>, has a multi-sport court, which is also to be used by students for physical education activities.

Installation of playground equipment and benches for the village square is also being planned to further allow for comfortable and healthy community life for residents and their families.

- **Community Center**

A community center, with an area of 62.81 m<sup>2</sup>, will also be placed next to the village square to add to the community life of the village. This building will hold the future village administration and a health center, which will be run in partnership with the municipal government.

Plans include a meeting room with a small kitchen and bathroom, an administration office, and two rooms reserved for the medical use. During the agricultural training phase of the resettlement program, training sessions will be held here.

- **Barn**

A barn, with an area of 504.00 m<sup>2</sup>, was designed to support the activities of the production program, and will be built on an area of 1,717 m<sup>2</sup>. The barn will be used to store farm produce. A workshop, tractor garage, and equipment and tool storage area will also be housed in the barn. A special driveway will be built to facilitate the loading and unloading of produce.

- **Chicken Coop, Pigpen And Shed**

Facilities for raising small farm animals were included in the project design in an effort to further meet the needs and desires expressed by participants in the resettlement program. The decision was reinforced by the advice of technical consultants involved in farm production, who emphasize the importance of raising small animals as a means of guaranteeing a protein source for the community residents.

These facilities will be placed behind the residential lots, as requested by the residents during the needs assessment and will be 75 square meters, including chicken coops and pigpens, as well as a shed to store feed and tools. Training in animal husbandry will also be included in the agricultural training program. Animal waste is to be used as agricultural fertilizer.

## **6. Agricultural Production Program**

Soil tests were conducted and local characteristics analyzed. Based on the results of this analysis, it was recommended that this farm village produce fruits and vegetables. The types of fruit and vegetables recommended by the technical consultants are considered easy to produce and market. Their growth cycle is also short and they can be produced throughout the year, guaranteeing higher productivity and profitability.

The production area consists of 334,159.56 m<sup>2</sup> and occupies 69% of the property. The area will include 60 rural plots divided into four different sections as follows:

1. Area for vegetables - 15 plots of 5,000 m<sup>2</sup> each to be exclusively used for vegetable cultivations.
2. Area for fruit growing 1- 15 plots of 5,000 m<sup>2</sup> each, intended for the cultivation of papaya together with corn (not irrigated).

3. Area for fruit growing 2- 15 plots of 5,000 m<sup>2</sup> each, intended for the cultivation of *acerola* together with pineapple (not irrigated).
4. Area for fruit growing 3 – 15 plots of 5,000 m<sup>2</sup> each, intended for the cultivation of guava together with corn (not irrigated).

## **7. Training Project**

In addition to resettling the resident families in better housing and living conditions, with capacity for agricultural production, agricultural training is needed in order to help the community to become economically self-sustaining.

A comprehensive questionnaire was given to the community to guide the design of the training program by first considering the educational profile of each resident. After exploring the skills and background of each family member, a six-month intensive training program was custom-designed to consider relevant training topics, appropriate training methodology, and the amount of time required to carry out the training.

Residents will receive training in agriculture and horticulture production, animal husbandry, and rural administration. Training, program monitoring, and follow up are expected to continue throughout about a five-year period. Additional training can then be provided as specific needs arise.

## **8. Government Partnerships**

Partnerships have been formed with local and state government agencies to facilitate and ensure sustainable development of the resettlement community. Partnerships with municipal government organizations include those formed in conjunction with: Secretaries of the Environment, Education, Agriculture and Social Activities; and at the state level: the organizations of EMATER and PESAGRO

have committed to assisting with the development and sustainability of the program by assisting with the marketing produce products from the settlement community.

## 9. Schedule

The proposed schedule implementation of the resettlement program is projected as follows:

- 6 months for construction of the residential area, to include housing, and the building of roads and community infrastructure.
- 12 months to set up the agricultural production program to include building of roads, land preparation, seeding, transplanting, maintenance, and harvesting.

The resettlement program will be consistently monitored and evaluated to ensure the accomplishment of program objectives. A formal evaluation process, based on World Bank Guidelines OD 4.3 (June 1990), will be used to measure program success, identify needed adjustments and modifications, and propose medium and long term solutions to any problems encountered.

Specific follow-up visits will be continued for a period of 12 months after completion of farm-village construction, resettlement of residents, and overall program initiation. Technical, social and legal factors will be considered and evaluated. It is hoped that after a year's period of time, residents will have reached a degree of self-sufficiency that will permit the continued development of new activities.

## 10. Costs

### El Paso Investments (Estimated)

- Purchase of the area R\$ 110,000.00
- Building Work R\$ 1,400,000.00
- Productive Project R\$ 460,000.00
- Training R\$ 150,000.00
- Consulting &
- Management R\$ 400,000.00

**Total R\$ 2,520,000.00**

**Total investment per family R\$ 168,000.00**

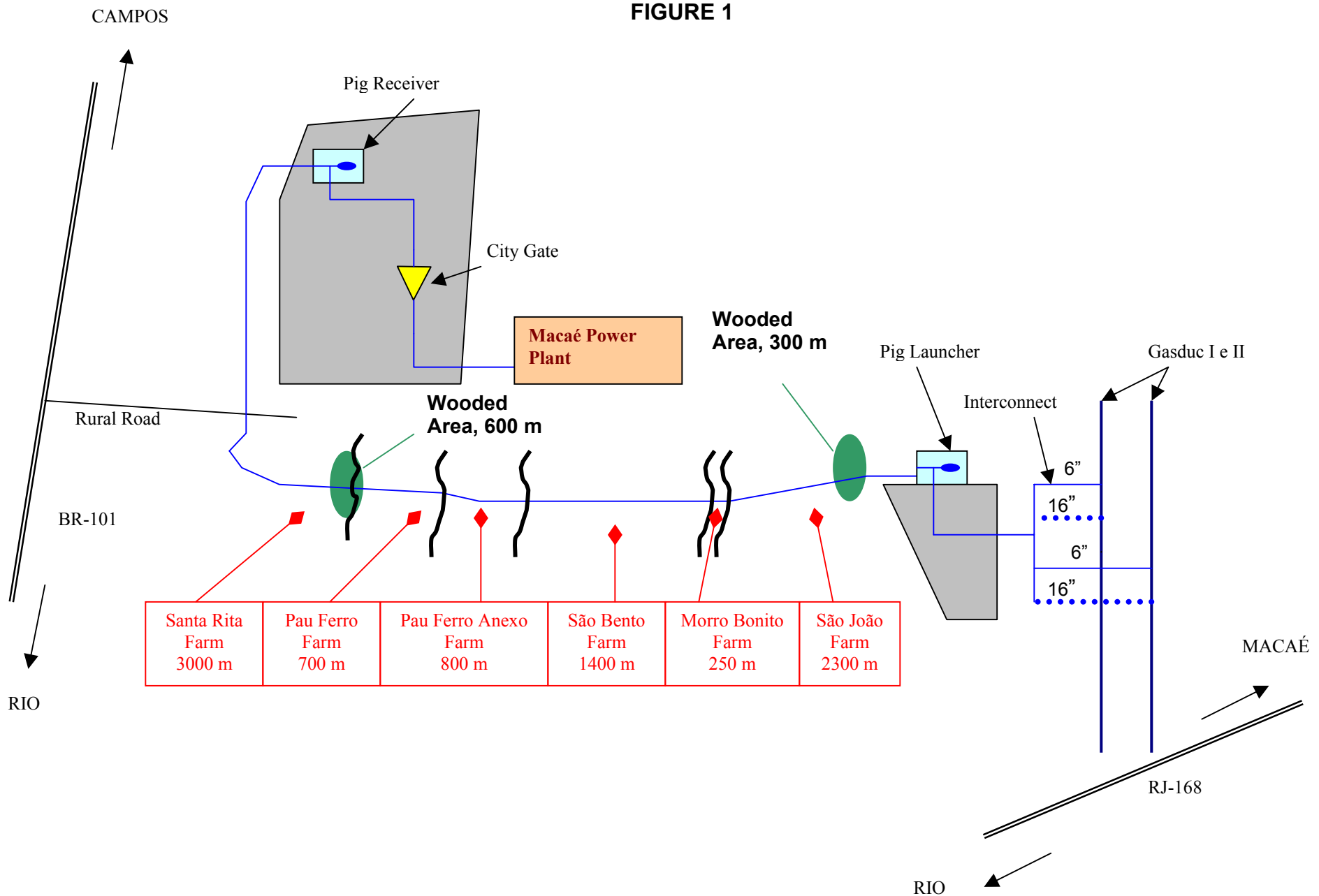
### Financial Projection for the Agricultural Program (per resettled family)

COSTS			
Year	Real R\$	Income	Profit
1	30,672.00 (El Paso)	38,899.00	38,899.00
2	25,999.00	61,362.00	33,152.00
3	26,568.00	61,362.00	32,535.00
4	29,282.00	66,362.00	34,590.00
5	28,514.00	70,651.00	39,712.00

## 11. Monitoring and Evaluation

It is expected that sustainability will begin to take hold within the first year of the Agricultural Program. Along the five initiation years the project will generate progressively increasing return on annual re-investments, reaching a maximum at the fifth year when the permanent cultures will be consolidated.

# DISTRIBUTION LATERAL FOR MACAÉ POWER PLANT FIGURE 1



## **SECTION 3**

# **PUBLIC CONSULTATION AND DISCLOSURE PLAN**

## SECTION 3

### PUBLIC CONSULTATION AND DISCLOSURE PLAN

#### 1. Background

This document describes the public consultation strategy and process undertaken by El Paso as part of the environmental program for the Macaé Merchant power plant project.

The Macaé Merchant plant venture is considered an emergency power project, approved by the National Electric Power Agency (ANEEL) in December 2000, because of Brazil's need to rapidly increase energy production to meet an energy shortage caused by successive droughts affecting hydropower generation, combined with a prolonged lack of investment in the energy sector. In light of the energy crisis, El Paso committed to having the project up and operating by the end of 2001. This commitment presented many technical, commercial, and logistical challenges inherent to the implementation of a project the magnitude of the Macaé Merchant power plant. An even greater challenge involved the need to undertake the fast-track project while also strictly complying with environmental laws and procedures by carefully following the environmental licensing process and the principles of good practice in environmental planning and management.

Potential environmental impacts were considered at the beginning stage of the project in making a site selection. Another important step involved surveying public opinion and soliciting input from local communities regarding their expectations and concerns regarding the project.

IFC Operational Policies (Document OP 4.01 on environmental assessment), was used to guide the public consultation process by indicating the minimum scope expected in carrying out the public consultation process during an Environmental Impact Assessment (EIA).

Familiarity with the community allowed El Paso to quickly develop public participation and planning strategies for the Macaé Merchant Project and actively involve local groups and citizens in the decision-making phase of the environmental licensing process. A public hearing was held in the process. As a result, the environmental impact studies included technical specifications provided by FEEMA, as well as concerns and expectations expressed by municipal government representatives, community associations, and non-governmental organizations regarding the Macaé Project.

Previously conducted consultation work made it possible to prepare the EIA/EIS in 60 days, so it was available for review by the environmental regulatory agency and the public. The community was able to analyze and discuss the document and results of the study prior to the public hearing.

## **2. Background of the Region**

The North Region of Rio de Janeiro State is composed of 9 municipalities: Campos dos Goytacazes, Macaé, São Fidelis, São Francisco de Itabapoana, São João da Barra, Conceição de Macabu, Quissamã, Cardoso Moreira and Carapebus.

The regional economic center is Campos dos Goytacazes, with a population of 389,547 inhabitants in 1996, which is the center in regards to the commercial, industrial and service activities of a significant part of the region.

The second regional center is Macaé (113,042 inhabitants in 1996) where the largest portion of industry and services is concentrated in oil exploration and production at the Campos basin. All remaining towns in the region present

population figures lower than 50,000 inhabitants, as most residents are concentrated in the two other municipalities.

Four of the towns within the influence area branched off from the larger cities and became separate municipalities: São Francisco do Itabapoana, (from São João da Barra), Quissamã and Carapebus (from Macaé) and Cardoso Moreira (from Campos dos Goitacazes).

According to the available data (Fundação Getúlio Vargas) the region presents one of the lowest income rates in the state of Rio de Janeiro (1.2 minimum wage, average), where Macaé represents the highest rates in the region (2.1 minimum wages) and São João da Barra the lowest (0.8 minimum wage).

### 3. Target Population Characteristics

The intense economic growth, changing demographics, and socio-environmental changes which occurred in Macaé as a result of PETROBRAS new presence in the 1970s also led to an increase in the number of community organizations. Community groups and associations became increasingly active in representing common concerns and interests.

Macaé has numerous grass roots organizations and is unique from other neighboring cities in respect to the degree, diversity, and pervasiveness of community organizations. There are three types of social organizations in Macaé: local residents associations or district associations; professional associations and workers' unions; and the local Non-Governmental Organizations (NGOs).

Districts or neighborhoods in the town of Macaé have a **district association**, with widespread and active participation. Many of the organizations hold monthly

meetings with the City Office of Social Development to discuss the town's problems and put forth the district demands.

The workers' unions are equally strong in Macaé and the Macaé Commercial and Industrial Association (ACIM) exercises political leadership in the town.

The Non-Governmental Organizations (NGOs) are represented by the MRA-5, Plenary Assembly of NGOs (MRA-5, "Macro Região Ambiental" is one of the environmental macro regions in which the state of Rio de Janeiro, Brazil is divided). Main organizations hold weekly meetings in Macaé to discuss environmental problems affecting surrounding municipalities included in MRA'5. These organizations are listed below:

- SOS Movement Praia do Pecado: Public awareness and activities for the protection of ecosystems, particularly sandbar vegetation.
- Ecological Cultural Association of the Municipality of Casimiro de Abreu – ACEMCA: Involved in preserving and increasing awareness of the Atlantic Rainforest, selective harvesting, and management, reforestation, and environmental education.
- Pró-Natura Institute: Promotes projects in the following areas: water resources, reforestation, carbon sink, and forests.
- Friends of the Jurubatiba Sandbar National Park – APAJ: Involved in escorting visitors to the PARNA Jurubatiba; carrying out environmental education activities, conducting talks and seminars in public and private schools, monitoring lawsuits involving PARNA and its surroundings, and handling accusations and offenses against PARNA.

- Macaense Environmental Protection Association – AMDA: Culture, Education and Citizenship Project, *Meio & Ambiente* magazine. Training and citizenship to increase awareness of environmental legislation, licensing, legal procedures, and environmental consulting.
- Rio das Ostras Ecological Movement – Involved in environmental education.
- Little Seed of Sana - Cultivation of seedlings (vegetable garden) and environmental education.
- 3HS Carapebus: - Research and projects in the area of the Jurubatiba National Park and Lagoa Feia, as well as environmental consulting.
- Environmental Action and Information Network - Increasing awareness, consulting, and environmental education.
- NGO 24 de Junho - Monitors government actions and works to increase awareness of community interests through lawsuits, special projects, eco-tourism, and landscaping studies.

The local university is also active in matters relating to the environment. The Macaé Nucleus of Environmental Studies (NUPEM), of the Federal University of Rio de Janeiro (UFRJ), in partnership with the Macaé City Hall and PETROBRAS, is active in the Lagoas Project and the Jurubatiba National Park, and conducts research and conservation activities for Macaé's sandbanks, coastal lagoons, marshes, water resources and Atlantic Rainforest.

The Regional Council of Engineering and Architecture (CREA) of Macaé, also has a significant role due to its high percentage of professional members in proportion to the size of the local population.

The Municipal Environment Office (MEO) plays an active role in the environmental affairs of the town. In spite of the abundance of environmental problems it faces, MEO has been successful in cooperating with community organizations. The MEO integrates environmental education throughout other municipal departments, particularly the education, agriculture and social action offices by influencing development of policy and promoting municipal revitalization programs.

#### **4. The Public Consultation Process**

In approaching the public consultation process, every attempt was made to establish a trust with community associations and groups by building on the communication channels which were opened up in carrying out prior studies for the other power plant in the region (Norte Fluminense).

The public consultation in Macaé was initiated by contacting NGO representatives and city government representatives and setting up focus group style meetings to discuss their issues and concerns regarding the plant. An event was also held to publicize and discuss the project with local trade associations and Macaé business community.

From that point, the public consultation process can best be discussed in terms of what was done prior to the public hearing and what occurred, and continues to occur, after the public hearing was held.

Brazilian regulations require that a public hearing be held within 45 days of submittal of an EIA to the environmental regulatory agency (in this case, FEEMA). In accordance with the mandatory procedures for public hearings, the regulatory agency makes the general public aware of projects and invites input and opinions. The agency also officially announces the time and place of the Public Hearing,

which should be published at least 15 days in advance, in mass-circulation newspapers.

The format of the hearing usually begins with a detailed explanation by the project developer of technical aspects of the project. An environmental consultant then discusses environmental implications and recommended mitigation measures. At that point, the public is invited to discuss matters of interest and make specific requests related to the environmental management of the project. Public concerns can also be outlined and described in writing and sent to the environmental regulatory agency for consideration. Written documentation must be submitted by a deadline established at the hearing, in order to be considered by the regulatory agency.

Prior to the public hearing, El Paso submitted copies of the EIA/EIS to the Macaé Environmental Office, which in turn made the document available for public review and consultation. Copies of the EIA/EIS studies were also given to the Plenary Assembly of the MRA-5 NGOs, which includes the environmental organizations of Macaé and neighboring towns.

From there the process expanded to the holding of meetings to discuss the studies, the licensing process, and management and environmental compensation programs, as described below:

- On November 20, 2000 a meeting was held with the Macaé Environmental Office to present the Macaé Merchant project, discuss potential impacts and control and mitigation measures, as well as potential project benefits.
- On December 12, 2000 a meeting took place with the Plenary Assembly of NGOs. In this meeting, the Plenary Assembly of NGOs was given an additional copy of the EIA/EIS for analysis and a discussion was held to present some of the main findings and clarify any questions.

- On December 13, 2000 a meeting was held with the City Environment Office to clarify questions raised by department technicians, and explore the city governments expectations for environmental compensation. An action plan for recuperation of the Macaé River and re-vegetation of riverbanks in the Macaé basin was also initiated.
- On February 5, 2001 a second meeting was held with NGOs to discuss the EIA/EIS. The NGOs requested more specific explanations of specific aspects of the project, namely: waste management, effluents treatment, use of water, the amount of earthwork, and the impact of air emissions. On this occasion, NGOs cited a need for more in-depth studies on the water resources of the Macaé river to assist SERLA in deciding on future concessions. They also expressed a concern about potential degradation of water springs and the Macaé basin, as a result of a lack of riverside vegetation around springs and along the water courses in the basin.
- On February 2001, an event was held at the Macaé tennis club. Local government and business representatives and Macaé trade associations were invited with the objective of discussing technical matters while also identifying opportunities to maximize local resources and increase local participation in the Macaé Merchant project.
- On February 15, 2001 the mandatory Public Hearing was held on the process of environmental licensing of the Macaé Merchant power plant. Community participation in the event was positive, as evidenced by correspondence sent to the environmental agency following the hearing, positive press coverage, and the calm nature of people gathered inside and outside the public hearing while it was taking place. The public hearing led to the inclusion of some specific restrictions in the text of the Preliminary License granted.

The Public Hearing proved valuable in facilitating in the licensing process, by guiding the decision-making process of the environmental regulatory agency responsible for granting licenses and defining necessary mitigation, monitoring, or compensation measures which were translated into specific restrictions in the licenses granted (see Annex Environmental Permits).

Socio-environmental questions raised by the community during the beginning phase of the consultation process and public hearing have been incorporated into the supervision, mitigation and environmental compensation programs included in the Environmental Management and Monitoring Plan for the plant. Community concerns included, for example, a potential increase in the migration of people to Macaé in search of work. To address this, specific strategies giving hiring and training priorities to local residents was built into El Paso' recruitment strategy. Also, El Paso took great care to develop a media strategy, which involved careful disclosure of the project to the immediate public and outlined hiring priorities as a way to prevent an influx of potential workers from outlying areas.

The public consultation process proved equally important in defining the Macaé plant's environmental compensation program. Two specific compensation plan agreements resulted from the community's desire for a reforestation program to increase riverside vegetation along the Macaé River and community concerns about water preservation.

Further meetings were held with the community after the Public Hearing, in order to keep the communication and information channels open. Presentations were held with the Macaé community on the Environmental Management and Monitoring Plan (EMMP) to be implemented, the progress of the construction, and the status of the compensation programs, as described below:

- On May 8, 2001 a "Seminar on Water Resources for the Macaé River" was held, to present the methodology to be used by El Paso in carrying out water

resource studies as part of an environmental compensation program of the Macaé Merchant project. The event was arranged by El Paso, in conjunction with SERLA, and was held in the auditorium of the Federal Technical School of Macaé-RJ.

- On May 15, 2001 a presentation on compensation programs was given to the MRA-5 regional NGOs. The presentation primarily focused on the development program for the Desengano State Park and research and reforestation strategies for the Macaé basin. A Committee called “Creation of the Macaé River Basin Pro-Committee” was formed at the meeting and will be coordinated by the MRA-5 Intercity Consortium, through the city council of Casimiro de Abreu – RJ.
- On May 21, 2001, presentations were made on the “impact of capital investments in the Macaé river basin”, for groups of secondary students of Colégio Castelo de Macaé, where impacts and benefits of the thermo power projects planned for the region were widely discussed.
- On June 20, 2001, El Paso made a presentation on the “Implementation of the Environmental Management and Monitoring Plan (EMMP)” and the “Prospects for Environmental Compensation for the Macaé Merchant project”.
- On 27 June, 2001, El Paso was invited to take part in a “Public Consultation” at the National Congress - Chamber of Deputies, Brasilia – DF, for “Discussion of the Environmental Impacts of Various Types of Electricity Generation.” El Paso reported on the licensing of the thermo power plants in Rio de Janeiro, especially the Macaé Merchant project. The event was organized by the Congressional Commission for Consumer Protection, Environment and Minorities.

- On July 30, 2001, a seminar on “*Reforestation of riverside vegetation and the importance of re-vegetation from the perspective of power project contractors*” was given at the invitation of the state environmental office (SEMADS), the State Superintendence of Rivers and Lagoons (SERLA), and the Fundação Instituto Estadual de Florestas (IEF). The event took place in the auditorium of the IERJ in Rio de Janeiro.
- On September 21, 2001 a public ceremony was held for the signing of the Environmental Compensation Agreements was held at the Guanabara Palace, with speeches by state authorities and various representatives of El Paso.
- On October 1, 2001 an event was held to present the plan for the Desengano State Park project in Municipality of Santa Maria Madalena, as part of the MRA-5 agreement.
- In October 2001, an event was held in the Macaé City Hall to officially confirm local agreements for all compensation programs.
- In November 2001, another presentation on the Environmental Management and Monitoring Program for the Macaé Merchant project was made to the Macaé community in the SESI Auditorium, Macaé.

## 5. Ongoing Public Consultation

In order to maintain an effective ongoing communication with the Macaé community, EL Paso is putting a Social Communication Program into place. The purpose of the program is to keep the public informed about the environmental performance of the Macaé Merchant Power Project. Two key strategies include:

- Making environmental monitoring reports available for review by the general public. Environmental reports will be made available for the Macaé community in the city Environmental Secretary's office. The reports will include water and air monitoring results as well on provide the status of El Paso's environmental programs.
- Creating a toll free (0800) line that can be used by the public to call and clarify any questions or concerns regarding the Macaé Plant. The plant would also be open to group visits and tours upon appointment.

In general, El Paso has a communications and marketing department that works closely with the Environmental Manager to continually seek ways to monitor public opinion, share project information, and develop environmentally and socially responsible programs. El Paso's commitment to public consultation is an ongoing process.

## **SECTION 4**

# **COMPLIANCE WITH IFC SAFEGUARD POLICIES**

## **SECTION 4 COMPLIANCE WITH IFC SAFEGUARD POLICIES**

### **1. Environmental Assessment**

The project is in fully compliance with OP 4.01- environmental assessment.

### **2. Involuntary Resettlement**

The project moved 17 families in fully compliance with OP 4.30 - Involuntary Resettlement.

### **3. The Archeological and Cultural Property**

The procedures followed by El Paso have complied with both Brazilian strict regulations about historical and archeological heritage and WB policy (World Bank Operational Note Nr. 11.03 - Management of Cultural Property in Bank Financed Projects).

The power plant site and the pipeline route were visited and analyzed by a team of experts. The site itself was found to possess no potential for pre-Colombian artifacts. An additional survey did not identify any material worthy of rescue.

### **4. Sponsor Commitment to Comply with IFC Policy Statement**

The terms of a letter expressing such commitment is presented below:

“The below signed legal representative of EL PASO RIO CLARO LTDA, which is part of the EL PASO ENERGY group, hereby ratifies his commitment to prevent,

denounce to the authorities in case it comes to his knowledge and pursue all possible legal means to avoid or amend any situation of harmful child or forced labor, as described in the IFC Policy Statement, in the course of the operation and decommissioning of the MACAE MERCHANT power plant.

This commitment will also be applied by MACAE MERCHANT management with respect to all contractors and suppliers.”

## **5. Natural Habitats**

The natural habitats protected by Brazilian law in the region are the conservation units Restinga de Jurubatiba National Park (19 km from site), Fazenda União Biological Reserve (18 km from site), and Atalaia Municipal Park (13 km from site).

The construction, decommissioning and operation of the power plant will not interfere with any of these habitats. An additional impact assessment to analyze air quality impacts was done for an area of 2,500 Km<sup>2</sup>.

Expected ground level concentrations of NO<sub>2</sub> are considered harmless to the flora and fauna of the region. The results of the test run using a computerized mathematical model presented in Section 8 of this report demonstrate that average ground level annual concentrations determined for class 1 sensitive areas is well below 2.5 µg/m<sup>3</sup>, the applicable Prevention of Significant Deterioration (PSD) increment for class 1 areas.

## **5. Natural Habitats**

All the vegetation management at the plant site will be conducted in accordance with OP 4.09 – Pest Management.

**SECTION 5**  
**COMPLIANCE WITH WORLD BANK**  
**ENVIRONMENTAL, HEALTH AND SAFETY**  
**GUIDELINES**

## SECTION 5

### COMPLIANCE WITH WORLD BANK ENVIRONMENTAL, HEALTH AND SAFETY GUIDELINES

The demonstration of compliance with World Bank Environmental, Health and Safety guidelines must prove that the environmental impact study has addressed all the relevant issues. The location and baseline studies have respected WB recommended limits for liquid effluents, atmospheric emissions and noise levels and have adequately analyzed actual and potential risks of accidents and impacts. These studies also have considered adequate mitigation and compensation programs.

#### **1. World Bank Pollution Abatement Handbook – Thermal Power – Guidelines for new Plants – July 1998**

This particular set of guidelines focuses relevant environmental issues in thermal power generation, providing orientation for baseline and impact studies. The guidelines also sets limits for liquid effluents, air emissions, air quality impacts and noise impacts, and sets specific guidelines for solid wastes management and monitoring programs.

The monitoring of air quality prior to operation by fully automated last generation air quality and meteorological stations is presently underway. The relevant parameters for the regional context (NO<sub>x</sub>, O<sub>3</sub>, PM and PM<sub>10</sub>, CO and SO<sub>2</sub>) will be analyzed and a specific addendum to this report will be prepared and presented to IFC. Macaé River water quality parameters and noise levels prior to plant construction have been properly measured and taken into account in the design of the plant control systems.

The amount of water authorized to Macaé Merchant is also a small fraction of the available flow for urban and rural uses and will not compromise any future demand – less than 4% of the total availability for human uses as demonstrated in the report.

Air quality in the impact area is typical of suburban/rural areas, with low concentration of NO<sub>2</sub> clearly the critical pollutant for a natural gas driven plant.

The quality of the river Macaé has been historically compromised by several human activities, namely sand extraction and sugar cane production (discharge of residues) but is close to the Brazilian Class 2 standard (Res. CONAMA 20/86) for most parameters of interest, as can be seen in Exhibit 1. This baseline data is relevant to explain the raw water treatment strategy defined by plant engineers and described in this report, as well as to evaluate the potential impacts of the discharge flow.

The tables below demonstrate that the plant has been designed to meet both liquid effluents and air emissions standards.

**Table 1**  
**Liquid effluents limits and applicable standards**  
**(mg/l, except as indicated)**

PARAMETER	DISCHARGE FLOW	ART. 21 RES. CONAMA 20/86	FEEMA NT-202.R-10	WORLD BANK
PH	6 - 9	5 - 9	5 - 9	6-9
Temperature	< 40 °C	< 40°C Increase at the edge of mixing zone < 3° C	< 40 °C Increase at the edge of mixing zone < 3° C	Increase at the edge of mixing zone < 3° C
Settling solids	< 1ml/l, Imhof test, 1 hour	< 1ml/l, Imhof test, 1 hour	NR	NR
Dissolved solids/solids in suspension	500/50	NR (see art 23)	NR	NR / 50
Oil and Grease	10 mg/l	20 mg/l	20 mg/l	10 mg/l
Copper	0.5 mg/l	1.0 mg/l	0.5 mg/l	0,5 mg/l
Soluble iron	1 mg/l	15 mg/l	15 mg/l	1 mg/l
Total chromium	0.5 mg/l	0.5 mg/l CR6 2.0 mg/l CR6	0.5 mg/l total	0.5 mg/l total
Zinc	1 mg/l	5 mg/l	1 mg/l	1 mg/l
Total heavy metals	10 mg/l	NR	NR	10 mg/l
Nitrates	10 mg/l	10	NR	NR
Sulfates	500 mg/l	NR	NR	NR
Phenolic substances C6H6OH	0.2 mg/l	0.5 mg/l	0.2 mg/l	0,5 mg/l
Phosphates (PO <sub>4</sub> )*	6 mg/l	NR	NR	6 mg/l
COD	150 mg/l	NR	150 mg/l	250 mg/l
BOD	15 mg/l	NR	>80% reduction	50 mg/l
Chlorides	750			
Chlorine (Residual)	0.2 mg/l	0.2 mg/l	0.2 mg/l	0,2 mg/l
Coliforms	400/100 ml	NR	Controle via DBO	400/100 ml

NR – not regulated

Note: discharge parameters after treatment, considering the characteristics of the intake raw water and the chemical products to be used in water treatment, cooling tower and demineralization units; WB limits as per Pollution Abatement Handbook – Guidelines for New Thermal Power Plants and General Guidelines, Art 21, Res. CONAMA 20 or Art 23, Res. CONAMA 20 – and NT.202 R.10, FEEMA, RJ.

The impact of this flow on the Macaé river will be non-significant, even in the dry season, given the instantaneous dilution rate of 12/4876, i.e. 1:406, considering the 12 l/s of the average discharge flow and the 4,876 l/s minimum river flow ( $Q_{7,10}$ ). Macaé river present water quality characteristics, as shown in Exhibit 1, reinforce the non-significant nature of the potential impact on water quality.

**Table 2**  
**NOx emission rates and related CT data for the LM 6000**

	RATES									
NOx	ppm	60	60	60	60	60	60	60	60	60
“Heat Rate”	kJ/kWh	8884	8936	8936	8936	8936	8936	8958	9054	9184
Fuel consumption	kg/s	2.42	2.32	2.315	2.315	2.315	2.315	2.27	2.14	2.02
Water injection	kg/s	1.63	1.50	1.498	1.498	1.498	1.498	1.43	1.24	1.05
Flow	kg/s	132.1	128.8	128.8	128.8	128.8	128.8	127.2	123.0	118.3
Temperature	°C	448.3	448.3	448.3	448.3	448.3	448.3	447.9	447.6	448.6

**Table 3**  
**Compliance with World Bank air emissions guidelines**

POLLUTANTS	MACAÉ PROJECT	BRAZILIAN REQUIREMENTS	WORLD BANK GUIDELINES	MITIGATION MEASURES
Nox	Up to 125,0 mg/Nm <sup>3</sup> (1)	Compliance evaluated by ambient air quality impacts – Res. CONAMA 03/90	125 mg/Nm <sup>3</sup> dry, 15 % O <sub>2</sub>	Water injection to control NOx emissions
	61 ppm		61 ppm	
Stack height	16.7m (2)	Not regulated	Good Engineering Practice	Not applicable

(1) Dry volume, zero degree Celsius, 1 atmosphere, 15% O<sub>2</sub>; 12.5 g/s or 126.8 mg/Nm<sup>3</sup> without correction for actual water and O<sub>2</sub> content in the exhaust flow was conservatively used for simulation purposes instead of 12.3 g/s (equivalent to 125 mg/Nm<sup>3</sup> also without correcting for water and O<sub>2</sub> content, given Macaé Merchant exhaust flow temperature) as explained in Section 8; El Paso is committed to operate the plant with emission rates below WB guidelines, but due to possible variations in the characteristics of the natural gas it is not technically feasible to guarantee emission rates as per GE specifications, as used in the EIA exercise.

(2) Initially the layout for the plant intended to have stack bases at 20 meters above sea level; final engineering design defined that the base of the stacks was to be 30 meters above sea level, which determined the reduction of stack height from 20 to 16.7 meters, without compromising good engineering practice.

**Table 4**

**Compliance with World Bank air quality guidelines – NO<sub>2</sub> (mg/m<sup>3</sup>)**

NO <sub>2</sub>	BACKGROUND LEVEL WITHOUT PROJECTS (A)	INCREMENTAL IMPACTS BY MACAÉ 16 TG (B)	CUMULATIVE IMPACTS BY MACAÉ 20 TG AND NORTE FLUMINENSE (C)	RESULTANT LEVELS (A+C) (**)	BRAZILIAN STANDARDS RES. CONAMA 03/90	WORLD BANK (*)
1-h Average	Continuous measurement underway (typical unpolluted ambient air has 7,5 to 9,4 ug/m <sup>3</sup> )	87,2	236,69	236,69	320	NR
Annual Average	Continuous measurement underway (typical unpolluted ambient air has 7,5 to 9,4 ug/m <sup>3</sup> )	2,13	4,3	4,3	100	100

(\*) World Bank Group air quality guidelines are to be used in the absence of host country air quality standards. These are presented for reference only. WB guidelines do not include a 1-hour limit for NO<sub>2</sub>. They do include, however, a 150 g/m<sup>3</sup> limit for 24-hour averages, which is not to be compromised by Macaé Merchant and UTE Norte Fluminense plus expected background concentrations, as explained in Section 7.

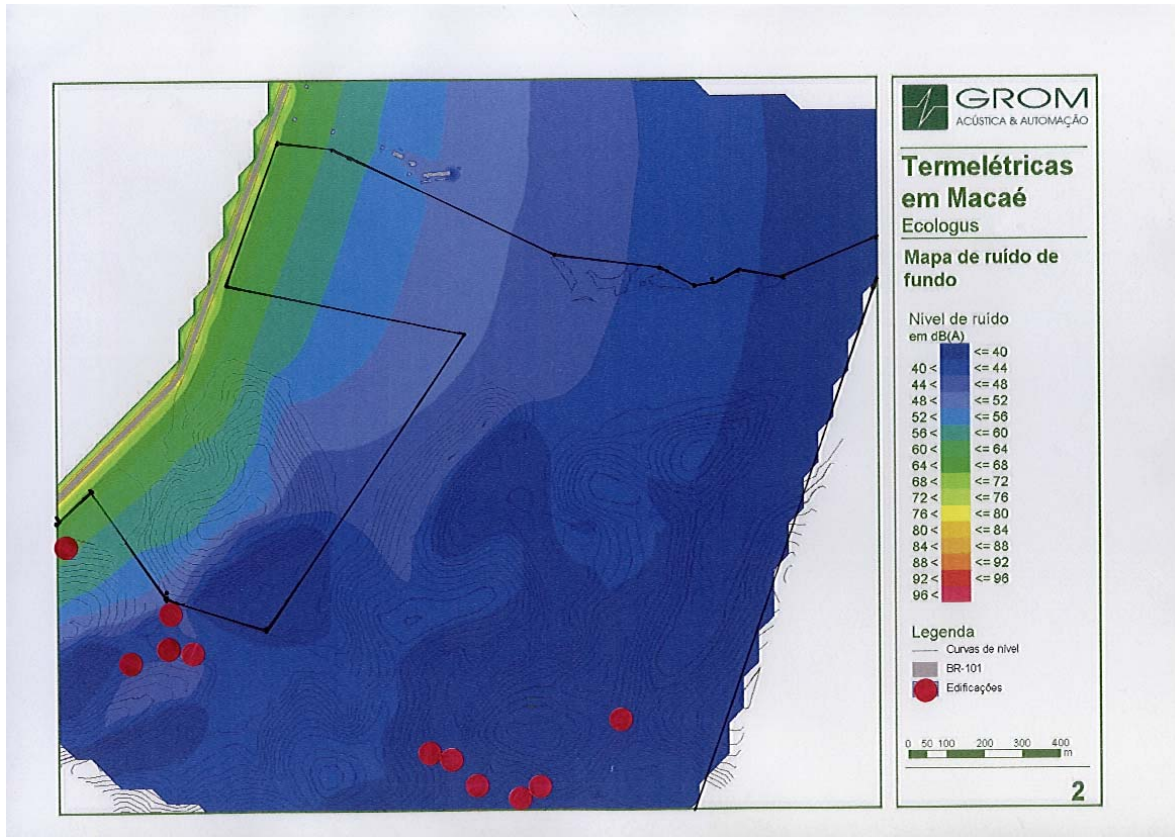
(\*\*) Maximum ground level concentrations are estimated to occur at 9,3 Km, SW direction for 1-h Average, and at 5,5 km, SW direction for Annual Average.

It is important to emphasize that the project will not operate any single CT in less than full load except in start-up and shutdown short periods (20 minutes, which is one of the characteristics which led to the selection of this particular type of CT) to avoid higher NO<sub>x</sub> emission rates.

Background noise levels are also typical of rural areas, and will not be significantly affected, as per the specific environmental impact report prepared for the expansion of Macaé Merchant.

The map in Exhibit 2 indicates the original 100 hectares fence line, the final 300 hectares fence line, the locations of the families to be relocated, the noise contour lines including 45 dba, and the closest residential receptor outside the 300 hectares fence line.

**Exhibit 1 – Map of Background Noise**



**2. IFC General Health and Safety Guidelines**

A quantitative risk analysis of both the power plant and the pipeline was prepared for the EIA to provide a basis for the on going implementation of the Risk Management Program and the Emergency Response Plan.

During construction, a rigorous Environmental Health and Safety Plan has been implemented to guarantee compliance with both Brazilian (NRs from the Ministry for Labor) and World Bank guidelines concerning workplace noise, work in confined spaces, health-general, safety-general, drinking water, training, occupational health and safety monitoring, records keeping and reporting.

The same set of concerns has been consolidated in the plant's operating manuals and has been used in the manpower's training program presently underway.

### **3. IFC General Health and Safety Guidelines for Polychlorinated Biphenyl**

No PCBs will be used in the transformers on site. Brazil has actually banned the use of such.

### **4. IFC Environmental Health and Safety Guidelines for Electric Power Transmission and Distribution**

MACAE MERCHANT will not be responsible for transmission or distribution of energy, since it will deliver its production at a FURNAS sub-station located on the very site.

FURNAS, the largest Brazilian power generator and transmission line operator, has an exceptional record of safety and respect for environmental protection. This can be easily demonstrated to the IFC if necessary.

### **5. World Bank Pollution Abatement Handbook Oil and Gas Development (On Shore)**

Though initially included in the MACAE MERCHANT project's permitting package, 9 kilometers natural gas pipeline will be operated by CEG, the State of Rio de Janeiro concessionaire, owned and operated by a consortium of multinational gas companies.

This company is only responsible (actually as a monopoly) for natural gas distribution in the State of Rio, and has no participation in the development or production of natural gas. It presently acquires natural gas from Petrobras.

The 9 kilometers gas pipeline is a lateral owned and operated by CEG and we do not know the present configuration of pressure reduction and control stations for the Macaé basin high-pressure transmission (Petrobras) and distribution network. Natural gas burning in pressure reduction stations, however, typically results in non-significant air emissions as compared to Macaé Merchant and UTE Norte Fluminense combined operations.

Finally it is stated that the project has full compliance with the Pest Management - OP 4.09. No pesticide is being or will be used in the plant site or gas pipeline corridor. Vegetation planting activity for landscaping will be managed by mechanical or manual procedures or by biological control methods.

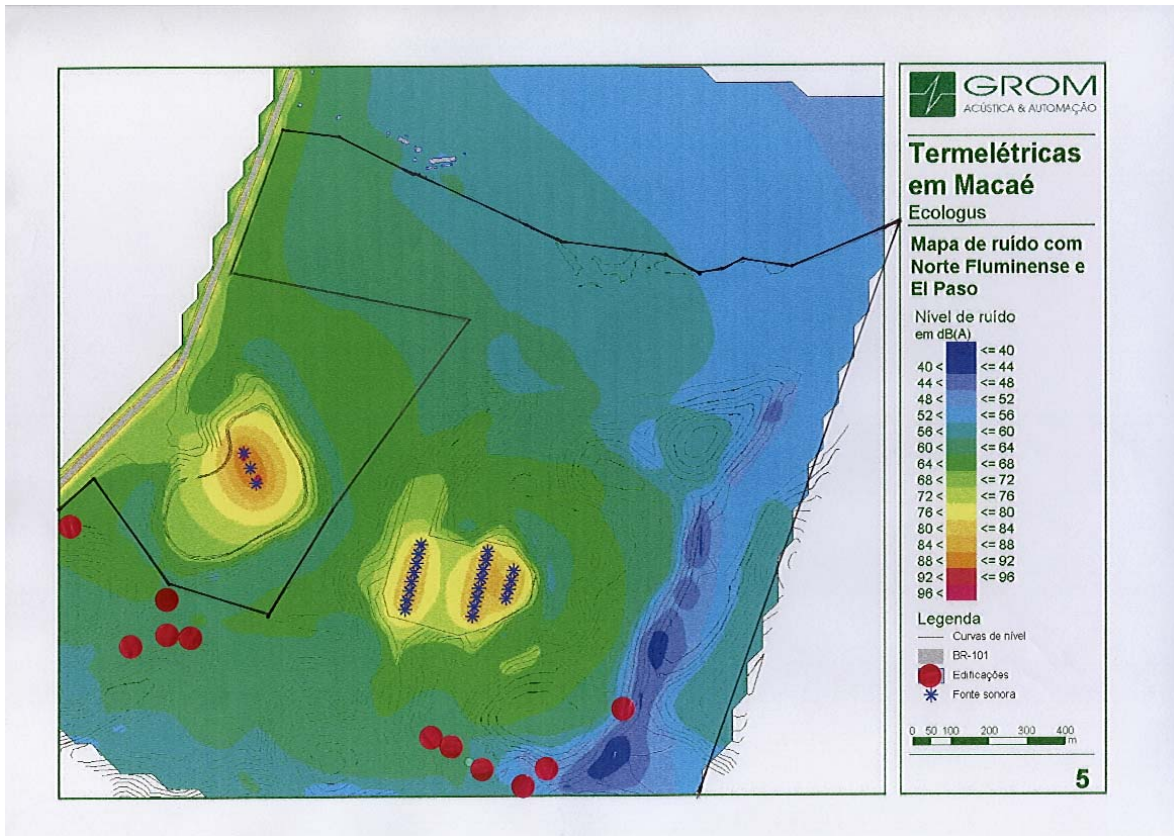
Presently the municipality of Macaé is engaged in the national program of *Aedes Aegypt* control, as an epidemic affecting public health is taking place in the country. The method adopted by health authorities is to use the biological pesticide TeKnar to asperse areas likely to house habitats for the mosquito. This pesticide is sprayed all over the rural area of Macaé, including the plant site. TeKnar chemicals are in compliance with OP 4.09. The pesticide company is authorized by the environmental state regulatory agency (FEEMA) to pest control in the area.

**Table 5**
**River Macaé physical, chemical and biological characteristics**

PARAMETERS	CONAMA 20/86 – CLASS 2	NR.. OF SAMPLE	MINIMUM VALUE	10%	90%	MAXIMUM VALUE
Temperature °C	NR	33	19	21	27	28
pH	6 a 9	34	6,4	6,53	7,57	7,8
Turbidity (UT)	100	34	3,5	5	30	35
DO – mg/l	5	35	0,1	6,4	8,4	9
Dissolved solids	500	2	40	46	94	100
Solids in suspension	NR	35	8	10	75	120
Lead – mg/l	0,03	32	0,002	<0,02	<0,02	0,02
Cianides – mg/l	0,01	20	0,01	<0,01	<0,01	0,025
Copper – mg/l	0,02	32	0,001	<0,005	<0,005	0,005
Zinc	0,18	22	0,001	ND	ND	0,07
COD – mg/l	NR	35	10	<10	<30	35
Total Phosphorous – mg/l	0,025	33	0,01	<0,036	<0,1	0,4
Phenolic substances – mg/l	0,001	21	0,001	<0,001	<0,005	0,009
Mercury – ug/l	0,2	28	0,1	<0,1	<0,13	0,35
Nitrites – mg/l	10	11	0,001	0,002	0,02	0,02
Ammonium nitrogen –mg/l	0,5	35	0,01	<0,01	0,066	0,3
Kjeldahl Nitrogen –mg/l	NR	32	0,15	0,255	0,8	3
BOD <sub>5,20</sub> – mg/l	5	35	2	<2,0	<5,28	60
Fecal coliforms	1.000 *	36	< 1	ND	ND	34

The map in Exhibit 2 indicates the original 100 hectares fence line, the final 300 hectares fence line, the locations of the families to be relocated, the noise contour lines including 45 dba, and the closest residential receptor outside the 300 hectares fence line.

**Exhibit 2 – Map of Noise with Norte Fluminense and El Paso Plants**



**SECTION 6**

**SOCIAL IMPACT ASSESSMENT**

## SECTION 6

### SOCIAL IMPACT ASSESSMENT

#### 1. Social Economic Baseline

The town of Macaé includes an area of 1,218.80 km<sup>2</sup> and has a population of approximately 115,000 inhabitants (1998). Sugar cane production used to serve as the basis of the Macaé economy. Once Petrobras built the Cabiunas Station in 1978, the town's economy became primarily industrial, commercial and service oriented and there was an increase in migration to the city by people seeking better employment opportunities. The expansion of the oil industry in the area generated over 7,200 direct jobs and 14,000 indirect ones. According to data provided by the Macaé City Treasury Department tax and royalties resulting from oil and gas production activities exceeded 100% between 1995 and 1999.

The first Development Plan for the city of Macaé was done in 1979. The plan was developed in response to the rapid population growth and uncontrolled urban expansion resulting from the new employment opportunities created by the installation of the Cabiúnas Station (Petrobras). Three new plans were proposed or reviewed from 1980 through 1989, addressing issues related to municipal zoning, demarcation of city limits to a land distribution law, and to impact assessments done in the region. These plans were never approved by the city government, but did form the basis of a Municipal Master Plan for Macaé (1990), which serves as the only urban plan presently used by the city.

Currently, the most important resource in the Macaé region is petroleum, which is explored in offshore fields at Campos Basin. Approximately 83% of proven oil reserves and 41% of Brazil's natural gas reserves are concentrated in this area.

Expected investments for the municipality over the next 5 years are over R\$ 10 billion. The types of services and industry will diversify creating new economic activities in the region, such as: lodging, catering, drilling companies, industrial assembly, heavy-duty mechanical services, transportation services and suppliers for offshore facilities.

Changes in the economy can already be observed in the tertiary sector that represents 41% of the municipal labor, while the secondary and primary sectors are represented only 8% and 4%, respectively. In the primary sector, cattle raising continues to represent 40% of the area's industry and the Macaé region is considered the third largest producer of cattle in the state of Rio de Janeiro.

Domestic sewage from the city of Macaé and outlying rural settlements is frequently disposed into the Macaé River. In the country, the effluents disposed are mainly generated by agricultural activities, like sugar cane farms and cattle ranches. This issue is currently under environmental focus by the state and local regulatory agencies and the municipal government as they seek solutions to this problem.

## **2. Economic Impacts**

### **2.1 Socio-economic Environment**

Strong social organization resulted from the intense economic and demographic growth and the socio-environmental changes caused in Macaé by the installation of Petrobras in the 1970s.

Grass roots organizations with advanced practices of social action and democratic process developed setting Macaé apart from other municipalities. Three main associations are instrumental in influencing public policy:

- **District Associations:** Community based organizations that represent the basic structure of Macaé society. These neighborhood or district associations are very influential and meet regularly with the Social Promotion Secretary to voice concerns and affect municipal decisions.
- **Workers' Unions:** these are equally strong in Macaé and the Macaé Commercial and Industrial Association – ACIM exercises political leadership in the town.
- **Non-Governmental Organizations (NGOs):** NGOs of Macaé are represented by MRA'5 Plenary Assembly of NGOs. These organizations hold weekly meetings in Macaé to discuss environmental problems affecting the surrounding municipalities included in MRA'5. These organizations include: SOS Movement Praia do Pecado, Ecological Cultural Association of the Municipality of Casimiro de Abreu (ACEMCA), Pró-Natura Institute, Friends of the Jurubatiba Sandbar National Park (APAJ), Macaense Environmental Protection Association (AMDA), Rio das Ostras Ecological Movement, and Little Seed of Sana.

The University is active in matters relating to the environment. The Macaé Nucleus of Environmental Studies (NUPEM), of the Federal University of Rio de Janeiro – (UFRJ), in partnership with the Municipal City Hall and Petrobras, it is active in the Lagoas Project and Jurubatiba National Park, carrying out research and conservation activities in respect of Macaé sandbanks, coastal lagoons, marshes, water resources and Atlantic Rainforest.

The Regional Council of Engineering and Architecture (CREA) of Macaé, also has a significant role due to the high percentage of professional members it has in relation to the size of the local population. This organization helped devise strategies for promoting public consultation and disclosure process of EIA.

## 2.2 Land Use in Project Area

The land selected for the plant site is located in a rural area. Ground elevation varies from 50 meters above sea level, at the top of scattered hills to 5 meters elevation in the plain areas along the riverbank. Earthwork done in constructing the plant reduced ground elevation to 30 meters. In addition to the main plant a smaller building was constructed for a water intake and pump station, at the bank of the Macaé River, 500 meters from the site entrance, at the opposite side of the BR-101 road. Landscaping is being done for that area to include revegetation along the riverbank. All remaining project structures are underground (gas pipeline and water pipeline) and do not significantly alter the landscape.

Since the power plant project is located in a rural area of Macaé, its installation required changing the land use from rural to industrial. The future installation of a new thermal power plant next to Macaé Merchant will contribute to this process as well. The Macaé administration has plans to change formal designation to industrial zone in order to create an alternative to the Cabiunas industrial zone, which is being impacted by urban expansion. The presence of a gas pipeline in the region will stimulate industrial development in the nearby Severina district, as small and medium scale industries take advantage of the availability of gas.

Use of land along the gas pipeline corridor will be restricted and no buildings will be permitted. However, the pipeline route does cross some cattle raising pastures.

The selected site has rural characteristics, with cattle raising as its main activity. A federal highway crosses the site and there is no environmental protected area and nature conservation unit in its immediate surroundings.

## 2.3 Employment Generation

To run the power plant, employees will need to be hired in the civil, mechanical and electrical fields. Labor demands frequently vary depending on construction and

production levels and demand for specific skills. In general the maximum number of employees at one time was approximately 1000. Employment of local manpower reached approximately 80% of that total.

As a priority, local labor was given employment preference. Many companies in the area provide construction and assembly services. As a result, the project attracted very little migration to the area by potential employees from outlying regions. This minimized potential social impacts on the community. Employees from other parts of Brazil or abroad were only hired to meet the demand for highly specialized labor for the electro-mechanical assembly of the plant.

In addition to the direct demand for employment to support Macaé Merchant plant construction and assembly, indirect employment opportunities have also been created by the plant through local commerce and services. Macaé Merchant operations have increased the demand for food, goods and materials, lodging, and transportation, stimulating a boost in the local economy.

Operation of the power plant should require a total of 50 permanent employees. Due to the small number of direct permanent jobs that the plant will be able to offer, social and demographic impacts at the operational stage of the project will be minimal. However, El Paso implemented a recruitment program, which includes supporting professional training programs to better prepare workers to compete for available positions and improve their technical skills for future opportunities.

## **2.4 Electricity Supply Reliability**

The Northern part of Rio de Janeiro state lacks a reliable power supply system. This is due to the poor condition of the interconnected South/Southeast/Middle West (S/SE/CO) electricity network. Macaé Merchant Power Plant is the first energy generation project that serves the region. Presently, the region relies solely on energy imported from other sectors of the electricity network.

Although there is an increasing demand for services created by the expansion of the oil and gas activity, the poor supply of energy has limited the number of investments in Macaé, because businesses have found the system unreliable.

The Macaé Merchant Project will greatly benefit Macaé, as well as the north of Rio de Janeiro and the state of Espírito Santo who is also faced with similar economic and energy challenges.

### **3. Ongoing to Community Development**

- Resettlement to assist population in the surrounding area of plant site presented on Section 2 of the Supplemental EIA.
- Continuous Public Disclosure of the project performance presented at Section 3 of the Supplemental EIA.
- Social Environmental Compensation Programs and Environmental Education Volunteer Programs presented at the Section 11 of the Supplemental EIA.

**SECTION 7**

**RATIONALE OF TECHNOLOGY SELECTION:  
LARGE SIMPLE CYCLE POWER GENERATION  
PROJECT**

## SECTION 7

### RATIONALE OF TECHNOLOGY SELECTION: LARGE SIMPLE CYCLE POWER

The Macaé Merchant Plant was built to operate as a merchant plant. The plant is only expected to run if either: (i) spot market prices are above a minimum level; or (ii) the regional electricity grid in the Rio-Espirito Santo area is capacity constrained (or technically unstable) and, as such, the system operator requests the plant to dispatch so as to reinforce the operation of the grid. Given the predominance of hydropower in Brazil, this operating regime is considered appropriate in that the plant is not expected to be dispatched when there is sufficient water in the country's reservoirs to meet peak demand. The plant's fuel supply arrangements and technology were developed in order to optimize the plant's flexibility so that it can effectively operate in the above manner.

In terms of technology choice, the Company decided to install 20 GE LM6000 engines operating in a single cycle mode for the following reasons:

- This equipment is extremely flexible and will allow the Company to meet the needs of the regional electricity system in an effective and efficient manner.
- The LM6000 engine is a unit with quick start-up capabilities and low start-up costs. These are important factors of a plant with expected daily start and stop operating characteristics.
- The selected technology is capable of dispatching efficiently in steps of 44 MW up to the maximum capacity of 870 MW. A combined cycle plant with the same output would have both a significantly reduced efficiency and a less attractive environmental performance if it had to operate at partial loads and with repeated starts and stops.

- The LM6000 engine is the most efficient gas turbine in its size range (40-70 MW), which has the environmental benefit of lower NO<sub>2</sub> and CO emissions as compared to other single cycle engines.
- Because of the energy crisis in Brazil and the resulting government-mandated electricity-rationing program, a high premium was placed by all parties on the fast-track implementation of the project. In this regard, the chosen technology could be placed in operation much more quickly than could a typical combined cycle technology. Macaé's actual fast-track implementation timeline has borne this choice out.

### **Expected Role of Macaé under the Priority Thermal Power Program**

The Macaé Merchant project is part of Electrobras' ten-year Power Sector Expansion Plan (2000-2009). The program has been designated a priority project by the Brazilian government in response to a short term goal (2000-2005) of dramatically increasing energy generation capacity in the Southeastern region of Brazil by building thermal power plants to meet the growing energy demands in the area. The Macaé Merchant Project is considered an emergency project within the Priority Program for Thermal Power Plants (PPT) and falls within the government's plan for the power sector by:

- Diversifying the generation sources in the national power configuration, to reduce disadvantages of relying almost totally on hydropower generation (current scenario).
- Strengthening the generation capacity within the Southeastern region, which draws its energy from the Southern/Southeastern/Mid-Western interconnected electricity system, which is primarily supplied by hydropower. A long draught led to the present power crisis in Brazil.

**SECTION 8**  
**IMPACT ASSESSMENT OF THE**  
**ECOLOGICALLY SENSITIVE AREAS**

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## SECTION 8

### IMPACT ASSESSMENT OF THE ECOLOGICALLY SENSITIVE AREAS

#### 1. Introduction

##### 1.1 Atmospheric Dispersion

The objective of this study is to estimate and analyze air quality impacts resulting from the emission of atmospheric pollutants from Macaé Merchant and UTE Norte Fluminense power plants. A computerized mathematical model (ISC3, a regulatory model in the USA context) is used for atmospheric dispersion. The analysis of air quality impacts considers Brazilian regulations, WB guidelines and *PSD* increments (*Prevention of Significant Deterioration Increments*) for Class I areas as per the USA clean air act.

#### 2. Mathematical Dispersion Model

In order to simulate the impact of the atmospheric emissions of the Plant, dispersion model ISC3-AERMODView (1999) was used. This model was originally developed by USEPA (the US Environmental Protection Agency) and the interface for Lakes Environmental Software of Canada developed Windows system. After various field tests, the model has been approved by USEPA for use in the permitting process for new fixed sources in the USA, hence its regulatory designation.

The model enables the consideration of various climatic scenarios and comes as close as possible, for a Gaussian type of model, to the physical reality of

atmospheric dynamics. The model has been widely used, both by the academic community and national and international environmental control agencies. The model accepts input data from more than 50 simultaneous sources and generates up to 1,200 receivers on the surface. The receivers are distributed within a Cartesian grid, the cells of which accept any size of area. In the present study, a 1 km<sup>2</sup> grid was adopted, covering a total surface area of 2500 km<sup>2</sup>, i.e. a 50 km x 50 km grid.

The basic Gaussian equation of the model assumes that the average concentration of pollutants emitted from a point source obeys a normal Gaussian distribution within the dispersion plume, according to the solution proposed by Pasquill. In the analytic solution it is assumed that the dispersion of the pollutants issued continually from the stacks obeys a normal distribution along the horizontal axis of the plume. The solution for obtaining the concentration is represented by equation (2) below. The basic assumptions and requirements of a Gaussian model, amongst others, are the following: adiabatic dispersion; wind and stability class basic data which are representative of local meteorological conditions; existence of a routine to extrapolate the wind speed data from the height of the meteorological mast to the mouth of the stack; definition of simple terrain or complex topography; definition of urban, rural or coastal areas. To estimate the height of the mixing layer based on surface and high-level meteorological data, the computer algorithm RAMMET View<sup>3</sup> was used. The ISC3 model allows flexibility for short term and long term dispersion studies, while requiring a minimum set of detailed meteorological data and forcing the use of field tested and reliable assumptions and algorithms (see reports EPA<sup>3 4 5</sup>).

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<sup>3</sup> U.S. Environmental Protection Agency, 1995 PCRAMMET User's Guide. U. S. EPA, Research Triangle Park, NC.

<sup>4</sup> U.S. Environmental Protection Agency, 1999. Addendum – User's Guide for the Industrial Source Complex (ISC3)

Dispersion Models (Revised), Volume 1. EPA-454/B-95-003. Office Of Air Quality Planning and Standards, Research Triangle Park, NC.

<sup>5</sup> U.S. Environmental Protection Agency, 1998 a. Revised Draft – User's Guide for the AMS/EPA – Regulatory Model –

$$C(x_p, y_r, z) = \frac{Q f_p}{2\pi u \sigma_y} \cdot \exp\left(\frac{-y_p^2}{2\sigma_y^2}\right) \cdot \sum_f \sum_{m=0}^{\infty} \frac{\lambda_j}{\sigma_{zj}} \left[ \exp\left(\frac{-(z - \Psi_{dj} - 2m z_j)^2}{2\sigma_{zj}^2}\right) + \exp\left(\frac{-(z + \Psi_{dj} + 2m z_j)^2}{2\sigma_{zj}^2}\right) \right] \quad (2)$$

Where,

$C_d(x, y, z)$  = Concentration of specific pollutant in space, [ $\mu/m^3$ ]

$u$  = Average horizontal velocity of surface wind, [m/s]

$\sigma_y, \sigma_{zj}$  = Standard horizontal and vertical deviation, [m]

$\Psi_{dj}$  = Effective Height of Source, [m]

$Q$  = Rate of Emission of Source, [g/s]

$z = \begin{cases} z_r = \text{for horizontal plume dispersion} \\ z_p = \text{irregularity of ground} \end{cases}, [m]$

### 3. Topography

The municipality of Macaé has a low-complexity topography. This factor represents an additional differential in applying the mathematical model to the region. A topographic map with contour lines has been used to generate a computer file for incorporation into the mathematical model. Only the chief target receptors and the location of Macaé Merchant are shown on the map. During data processing by the model, the topographic correction function uses data on the relief of the region to generate results compatible with the actual features of the area. The topographic configuration generated by the model is shown in **Figure (1)**.

AERMOD. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

<sup>6</sup> U.S. Environmental Protection Agency, 1998 b, Revised Draft – User’s Guide for the AERMOD – Terrain Preprocessor (AERMAP). Office of Air Quality Planning and Standards. Research Tringle Park, NC.

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## 4. National Ambient Air Quality Standards and PSD Increments

### 4.1 Assessing Project Impacts - Ambient Air Standards

National Ambient Air Quality Standards U.S.A. - The 1970 Clean Air Act (and its amendments) was enacted by American Congress to protect the health and welfare of the public from the adverse effects of air pollution. Subsequently, the EPA established National Ambient Air Quality Standards for six criteria pollutants: sulfur dioxide or SO<sub>2</sub>, particulate matter less than 10 microns or PM<sub>10</sub>, nitrogen dioxide or NO<sub>2</sub>, carbon monoxide or CO, ozone or O<sub>3</sub>, and lead or Pb, and PSD - Prevention of Significant Deterioration increments for three pollutants - SO<sub>2</sub>, PM<sub>10</sub>, and NO<sub>2</sub>. The NAAQS specify maximum concentrations for various averaging times below which the air quality is considered acceptable with an adequate margin of safety and they include both primary and secondary standards.

The primary standards are intended to protect human health, whereas the secondary standards are intended to avoid minimum adverse effects on public health and to protect public welfare (e.g., damage to vegetation) from any known or anticipated adverse effects associated with the presence of air pollutants. The NAAQS for short-term periods (24 hours or less) are not to be exceeded more than once per year. Long-term NAAQS refer to limits that cannot be exceeded for averaging periods over three months or longer.

The Brazilian NAAQS have been developed for various averaging periods with the same basic definitions of primary and secondary standards, and are similar to those applied in the USA for the same pollutants. Brazil has no PSD regulations though Res. CONAMA 03/90 does force the applicant for a permit of any new source to demonstrate, by appropriate baseline and dispersion studies, that the primary air quality standards will be respected. Brazil also has a nationally defined concept of Class 1 areas (Res. CONAMA 08/90), though these depend on State designation, which has not happened, as yet, in the State of Rio de Janeiro.

## 4.2 A PSD – Prevention of Significant Deterioration - Increment

The most common reason industrial sources are required to conduct dispersion studies is to satisfy the requirements of the Prevention of Significant Deterioration (PSD) rules. A PSD increment is the maximum allowable increase in concentration above a baseline concentration for a given pollutant. The baseline concentration is generally defined as the concentration existing at the time that the first complete PSD permit application affecting the area is submitted. It is important to note that the air quality cannot deteriorate beyond the concentration allowed by the applicable NAAQS, even if not all of the PSD increment is consumed. The PSD increments, the Brazilian NAAQS and World Bank reference standards, are presented in **Table 1**.

The purpose of the PSD program for Class 1 areas is to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value. The mandatory *Class 1 areas* in the USA include the following, as of August 7, 1977:

1. International parks
2. National wilderness areas and national memorial parks in excess of 5,000 acres
3. National parks in excess of 6,000 acres
4. To require that major new stationary sources and major modifications are carefully reviewed prior to construction to ensure compliance with the NAAQS and applicable air quality increments.

**Table 1**  
**Brazilian Air Quality Standards (Resolução CONAMA N°.03/90), PSD**  
**Increments and World Bank Reference Standards**

Pollutant	Condi tions  AVERAGING Period	RES. 03/90 CONAMA - NAAQS		USEAPA PSD - INCREMENTS		WORLD Bank *
		Primary	Secondary	Class I	Class II	
SO <sub>2</sub>	24 - hour	365	150	5	91	150
	Annual	80	60	2	20	80
PM total	24 - hour	240	150	NR	NR	230
	Annual	80	60	NR	NR	80
PM <sub>10</sub>	24 - hour	150	150	8	30	150
	Annual	50	50	4	17	50
NO <sub>2</sub>	1 - hour	320	190	NR	NR	150 (24 hours)
	Annual	100	100	2,5	25	100
CO	1-hour	40,000	40,000	NR	NR	NR
	8-hour	10,000	10,000	NR	NR	NR

NR – not regulated

\*See Pollution Abatement Handbook, July 1998, Guidelines for New Thermal Power Plants.

## 5. Discrete Receptors

**Table 2** shows the location of the relevant receptors in the project potential impact area, including the four “ Class 1” areas in bold letters. They have been identified in the baseline studies and have been flagged for specific model calculations: Fazenda Severina, Fazenda das Pedrinhas, Fazenda da Saudade, Capela Santo Antonio, Capela N.S. das Neves, Macaé Hospital and Horto Florestal, Restinga de Jurubatiba National Park, Fazenda União Biological Reserve, Atalaia Municipal Park.

The pollutants may affect these locations depending on the wind direction. Since the prevailing winds are from the Northeasterly (NE) quadrant, the most vulnerable receptors are those located to the Southeast of the Thermal Power Plant.

**Table 2**  
**Location of the discrete receptors in the influence area of the**  
**Macaé Merchant Thermal Power Plant**

LOCATION OF RECEPTOR	RECEPTOR COORDINATES ( M )			DESCRIPTION OF DIRECTION OF RECEIVER
	EAST (X)	NORTH (Y)	ALTITUDE (M)	
Fazenda Severina	500	-1250	20	South of the Plant
Fazenda das Pedrinhas	-4000	-3750	30	Southwest of the Plant
Fazenda Saudade	-5000	3250	10	North of the Plant
Capela Sto. Antonio	-6750	-4750	10	Southwest of the Plant
Capela N.S. das Neves	-8500	-3750	10	West-Southwest of the Plant
Macaé Hospital	10000	-7000	10	Southeast of the Plant
Horto Florestal	7250	-7500	11	South-Southeast of the Plant
Jurubatiba National Park	19250	1750	9	North-East of the Plant
Fazenda Uniao Biological	-13750	-10250	19	Southwest of the Plant
Atalaia Municipal Park	-11750	250000	8	West of the Plant

## 6. Source Specs

The emission rates of UTE Norte Fluminense and Macaé Merchant Thermal Power Plants, using natural gas, are listed in **Table 3** for Nitrogen Oxides, NO<sub>x</sub>. This study does not consider the emissions of Sulfur Oxides, SO<sub>x</sub>, Total Hydrocarbons, THC, Particulate Matter, MP and Carbon monoxide, CO, because the maximum concentrations of these substances do not significantly affect background levels, given the emission rates considered and the dispersion studies presented in the EIA. Only Nitrogen Oxides, NO<sub>x</sub>, do deserve special attention for natural gas driven power plants, as widely recognized. **Table 3** also shows the height of the 23 stacks, the exit velocities, the temperatures of the exhaust gases, the volumetric flows, the diameters and the location of each point source.

The emissions data-set below and the meteorological data of the Macaé Airport station, are the chief inputs to ISC runs designed to estimate short term and long term ground level concentrations of NO<sub>2</sub> in the region.

Gas heaters at the gas-receiving terminal also emit NO<sub>x</sub> but these were not included in the analysis because the emission amount is very small compared to those from Macaé Merchant and UTE Norte Fluminense.

**Table 3**  
**Input parameters for the Model of Macaé Merchant and Norte Fluminense**  
**Thermal Power Plant emissions, gas-fired**

SOURCES	CARTESIAN COORDINATES		SMOKE -STACK (m)	DIAMETER (m)	FLOW m <sup>3</sup> /s	EXIT TEMP. (°K)	EXIT VELOCITY (m/s)	NOX g/s
	X (m)	Y(m)						
Smokestack 1	-200.0	0.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 2	-190.0	25.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 3	-185.0	50.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 4	-180.0	75.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 5	-175.0	100.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 6	-170.0	120.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 7	-165.0	145.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 8	-158.0	170.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 9	45.0	145.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 10	40.0	120.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 11	32.0	95.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 12	25.0	70.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 13	20.0	45.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 14	15.0	20.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 15	10.0	-5.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 16	0.0	-25.0	16.7	3.5	256.9	711.6	26.7	12.5
Norte Flu. 17	-620.0	425.0	40	5.0	412.300	366.0	21.0	19.38
Norte Flu. 18	-655.0	275.0	40	5.0	412.300	366.0	21.0	19.38
Norte Flu. 19	-690.0	325.0	40	5.0	412.300	366.0	21.0	19.38
Smokestack 20	104.0	10.0	16.7	3.5	256.9	711.6	26.7	12.5

SOURCES	CARTESIAN COORDINATES		SMOKE-STACK (m)	DIAMETER (m)	FLOW m <sup>3</sup> /s	EXIT TEMP. (°K)	EXIT VELOCITY (m/s)	NOX g/s
	X (m)	Y(m)						
Smokestack 21	110.0	32.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 22	120.0	60.0	16.7	3.5	256.9	711.6	26.7	12.5
Smokestack 23	132.0	84.0	16.7	3.5	256.9	711.6	26.7	12.5

There is no emission limit for NO<sub>x</sub> in the Brazilian emission control legislation. Therefore, the WB recommended limit of 125 mg/Nm<sup>3</sup> (dry volume and 15% O<sub>2</sub>) was used. A round conservative 12.5 g/s emission rate for each CT was considered in all simulations<sup>1</sup>, though the actual emission rate calculated for 125 mg/Nm<sup>3</sup> would be 12.3 g/s, without correcting for water and O<sub>2</sub> actual content. If this correction were made, considering that typically a single cycle CT operation with water injection will generate some 8% of H<sub>2</sub>O and 12 % O<sub>2</sub> in the exhaust flow, the emission rate conservatively used for simulation purposes would be even higher, i.e. close to 130 mg/Nm<sup>3</sup>, dry volume and 15% O<sub>2</sub>. El Paso operating procedures will guarantee, nevertheless, emission rates below 125 mg/Nm<sup>3</sup>, dry volume and 15% O<sub>2</sub>, as per WB guidelines. It must be pointed out in this respect, that atmospheric dispersion modeling is not accurate enough to handle small differences in emission rates, and that the conservative emission rate used for simulation purposes serves solely for showing worst-case possible consequences.

El Paso is thus committed to operate the plant with emission rates below WB guidelines, but due to possible variations in the characteristics of natural gas to be supplied to the plant it is not technically feasible to guarantee emission rates as per the GE standard guarantee (which only holds for given natural gas specs) used in the EIA exercise.

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<sup>1</sup> In the EIA exercise a lower emission rate was used, according to GE preliminary specs for the LM 6000. It was decided to use the WB limit in the subsequent LI and LO stages of the permitting process, in order to evaluate “ worst case scenario” potential consequences of variations in the conditions of the natural gas to be supplied by CEG.

Initially the layout for the plant was intended to have stack bases at 20 meters above sea level; final engineering design defined that the base of the stacks was to be 30 meters above sea level, which determined the reduction of stack height from 20 to 16.7 meters, without compromising good engineering practice.

The study further assumes that all  $\text{NO}_x$  is transformed into  $\text{NO}_2$  when it enters the atmosphere. According to the document *USEPA - APTI*, (1980)<sup>5</sup>, tests carried out with fossil fuel burning showed that the  $\text{NO}_2$  content of total  $\text{NO}_x$  measured is less than 75% and the  $\text{NO}$  content less than 25%. Transformations of  $\text{NO}$  to  $\text{NO}_2$  occur in the atmosphere, but slowly and partially, depending on the weather conditions and the time of year.

## 7. Study Grid

The Cartesian grid used the base of the main stack as its origin. The dimensions of the grid are (50 km) x (50 km), which covers an area of 2500 km<sup>2</sup>. Within this grid the model interpolates and generates another 625 receivers to better visualize the results of the dispersion simulation and to incorporate 7 relevant discrete receptors, enabling the plotting of iso-concentrations contours to identify the maximum concentration levels at these points.

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<sup>5</sup> USEPA – APTI – Course 427 Combustion Evaluation - $\text{NO}_x$  Control Theory - EPA 450/2 80 – 063. (16.1 – 5) pp. 1980.

## 8. Results

**Tables 4, 5 and 6** show the average maximum concentrations resulting from the mathematical simulation based on the emissions from the plants for the pollutants Nitrogen Oxides, NO<sub>x</sub>, only. *In this study it was not considered the emissions of the pollutants Sulfur Oxides, SO<sub>x</sub>, Total Hydrocarbons, THC, Particulate Matter, MP and Carbon monoxide, CO, because the maximum concentrations of these substances must be at a background level or a little bit above it.*

### *Nitrogen Oxides, NO<sub>x</sub>,*

The maximum concentrations of *Nitrogen Oxides, NO<sub>x</sub>*, expressed as NO<sub>2</sub>, obtained from the simulation are presented in **Table 4**. The results were obtained based on isolated emissions from each stack. After integration of the 23 sources the maximum integrated 1-hour concentration was 236.69 µg/m<sup>3</sup>. This maximum integrated 1 hour average concentration corresponds to 73% of the primary air standard of 320 µg/m<sup>3</sup>. The individual concentrations for each Plant are well below the limits established for NO<sub>2</sub>. The maximum average integrated annual concentration considering the two Plants is 4.3 µg/m<sup>3</sup>, which is just over 4% of the annual standard limit of 100 µg/m<sup>3</sup> for NO<sub>2</sub>.

**Table 5** shows the 20 highest maximum 1-hour average concentrations in decreasing order, and **Table 6** shows the ten highest average annual concentrations, also in decreasing order.

Based on these results and the distribution of concentrations over the entire receptor grid area, a map of isoconcentrations for the maximum 1hour average concentration was prepared as shown in **Figure 3**. It shows that the maximum 1 hour concentration takes place Southwest of the Plants and that the closest

receptor is Capela N.S. das Neves. **Figure 4** presents the annual isoconcentration contours, showing that the maximum annual average concentrations occur close to Fazenda das Pedrinhas.

**Table 4**  
**Maximum ground level concentrations of NO<sub>2</sub> and applicable standards –**  
**UTE Norte Fluminense and Macaé Merchant Thermal Power Plants.**

CONDITIONS  SOURCES	MAXIMUM NO <sub>2</sub> CONCENTRATION - UG/M <sup>3</sup>				STANDARD FOR NO <sub>2</sub> (µg/m <sup>3</sup> )	
	Average 1 hour Cmax.		Average Annual Cmax.		1 hour	Annual
	1 <sup>a</sup> . Max.	Coord.(m)	1 <sup>a</sup> . Max	Coord.(m)		
Stack 1	7.52	X =-8.500 Y =-3750 Z =50	0.096	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 2	7.53	X =-8500 Y =-3750 Z =110	0.096	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 3	7.62	X =-8500 Y =-3750 Z =110	0.097	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 4	7.69	X =-8500 Y =-3750 Z =110	0.098	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 5	7.73	X =-8500 Y =-3750 Z =110	0.098	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 6	7.75	X =-8500 Y =-3750 Z =110	0.099	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 7	7.75	X =-8500 Y =-3750 Z =110	0.100	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 8	7.73	X =-8500 Y =-3750 Z =110	0.100	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 9	7.59	X =-8500 Y =-3750 Z =110	0.092	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 10	7.50	X =-8500 Y =-3750 Z =110	0.092	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 11	7.49	X =-8500 Y =-3750 Z =50	0.091	X =-4000 Y=-3750 Z =60	320.0	100.0

CONDITIONS  SOURCES	MAXIMUM NO <sub>2</sub> CONCENTRATION - UG/M <sup>3</sup>				STANDARD FOR NO <sub>2</sub> (µg/m <sup>3</sup> )	
	Average 1 hour Cmax.		Average Annual Cmax.			
	1 <sup>a</sup> . Max.	Coord.(m)	1 <sup>a</sup> . Max	Coord.(m)	1 hour	Annual
Stack 12	7.55	X =-8500 Y =-3750 Z =50	0.090	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 13	7.62	X =-6750 Y =-4750 Z =50	0.090	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 14	7.65	X =-8500 Y =-3750 Z =50	0.090	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 15	7.67	X =-8500 Y =-3750 Z =50	0.089	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 16	7.67	X =-8500 Y =-3750 Z =50	0.089	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 17	63.01	X =-8500 Y =-3750 Z =110	0.814	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 18	62.21	X =-8500 Y =-3750 Z =110	0.814	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 19	60.62	X =-8500 Y =-3750 Z =110	0.816	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 20	7.65	X =-8500 Y =-3750 Z =50	0.087	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 21	7.68	X =-8500 Y =-3750 Z =50	0.087	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 22	7.69	X =-8500 Y =-3750 Z =50	0.087	X =-4000 Y=-3750 Z =60	320.0	100.0
Stack 23	7.69	X =-8500 Y =-3750 Z =50	0.088	X =-4000 Y=-3750 Z =60	320.0	100.0
<b>Integration of All Sources</b>	<b>236.69</b>	<b>X =-8500 Y =-3750 Z =50</b>	<b>4.30</b>	<b>X =-4000 Y=-3750 Z =60</b>	<b>320.0</b>	<b>100.0</b>

**Table 5**  
**Classification of the twenty highest, *hourly averages*, concentrations**  
**Obtained from the mathematical simulation for the pollutant NO<sub>x</sub>,**  
**Considering simultaneous emissions by**  
**Macaé Merchant and Norte Fluminense Thermal Power Plants.**

RANK	CONCENTRATION ( µg/m <sup>3</sup> )	COORDINATES	
		X(m)	Y(m)
1	236.69	-8500	-3750
2	228.88	-8500	-3750
3	228.88	-8500	-3750
4	228.10	-8500	-3750
5	225.85	7250	-7500
6	220.41	-8500	-3750
7	217.73	7250	-7500
8	208.78	7250	-7500
9	204.57	7250	-7500
10	204.57	7250	-7500
11	202.52	7250	7500
12	202.68	7250	7500
13	201.68	7250	7500
14	198.96	-8500	3750
15	198.38	-8500	3750
16	198.38	-8500	3750
17	198.10	7250	7500
18	198.10	7250	7500
19	197.93	-8500	3750
20	197.93	-8500	3750

**Table 6**  
**Classification of the 10 highest, *annual averages*, concentrations**  
**Obtained from the mathematical simulation for the pollutant NO<sub>x</sub>,**  
**Considering simultaneous emissions by**  
**Macaé Merchant and Norte Fluminense Thermal Power Plants.**

RANK	CONCENTRATION ( $\mu\text{g}/\text{m}^3$ )	COORDINATES	
		X(m)	Y(m)
1	4.30	-4000	-3750
2	2.78	-6750	-4750
3	2.08	-8500	-3750
4	1.94	-6000	-8000
5	1.93	-6000	-9000
6	1.91	-7000	-9000
7	1.91	-5000	-7000
8	1.91	-7000	-10000
9	1.91	-5000	-8000
10	1.90	-6000	-10000

## 9. Discrete Receptors

**Table 7** shows the maximum hourly concentrations of NO<sub>2</sub> at the discrete receptors points identified previously. The maximum annual average of 4.3  $\mu\text{g}/\text{m}^3$  occurs at Fazenda das Pedrinhas, and it is well below the annual limit of 100  $\mu\text{g}/\text{m}^3$  and the respective PSD increment of 25  $\mu\text{g}/\text{m}^3$ , applicable to a class 2 area.

The results also demonstrate that the concentrations for class 1 areas are well below annual PSD increments and will not cause significant impact on the Horto Florestal, Jurubatiba National Park, Fazenda União Reserva Biologica and Atalaia Municipal Park. The threshold NO<sub>2</sub> level for damage to plant and wild life is a complex issue, but there is clear evidence that continuous exposure to 0.5 ppm

NO<sub>2</sub> concentration levels (1,250 µg/m<sup>3</sup>) will inhibit plant growth (see for instance Davis, M. and Cornwell, D.A. “Introduction to Environmental Engineering” McGraw Hill International Editions, 1991) and many countries, including Brazil, have set the alarm level for NO<sub>2</sub> using this order of magnitude.

**Table 7**  
**Maximum incremental annual concentrations of NO<sub>2</sub> at the relevant discrete receptors and class 1 sensitive areas, identified in the influence area of Macaé Merchant and Norte Fluminense Thermal Power Plants**

DISCRETE RECEPTOR	CONCENTRATION OF NO <sub>2</sub> ANNUAL AVERAGE ( µG/M <sup>3</sup> )	PSD-INCREMENTS		RECEPTOR COORDINATES	
		CLASS I AVERAGE ANNUAL	CLASS 2 AVERAGE ANNUAL	(X) (M)	(Y) (M)
Fazenda Severina	0.588	NA	25	500	-1250
Fazenda das Pedrinhas	4.307	NA	25	-4000	-3750
Fazenda Saudade	1.181	NA	25	-5000	3250
Capela Sto. Antonio	2.782	NA	25	-6750	-4750
Capela N.S. das Neves	0.904	NA	25	-8500	-3750
Macaé Hospital	2.084	NA	25	10000	-7000
Horto Florestal	1.482	2.5	NA	7250	-7500
Jurubatiba National Park	0.319	2.5	NA	19250	1750
Fazenda Uniao Biological	1.400	2.5	NA	-13750	-10250
Atalaia Municipal Park	1.010	2.5	NA	-250	-11750

PSD increments for 1-hour NO<sub>2</sub> concentrations have not been established. Short-term exposures may indeed not cause significant adverse effects to the public or the environment. Nevertheless, a discussion of ISCST results considering the Brazilian 1 hour maximum primary standard, and the probable background concentrations, is included in the next and final section of this report.

## 10. Background Concentrations and Conclusions

Air quality monitoring in Brazil is the responsibility of state governments (res. CONAMA 03/90, Art. 4). Nevertheless, El Paso provided FEEMA with resources to undertake the continuous monitoring of NO<sub>2</sub> ground level concentrations three months ago. Due to institutional coordination difficulties, the station was initially placed kerb-side with respect to the federal highway and no proper plan for covering the discrete receptors targeted in the dispersion studies for Macaé Merchant was made. The results then obtained did not present the required consistency, possible as a result of calibration deficiencies in addition to the above.

Additional measurements oriented towards the targets identified in this report are underway and will be made available soon.

In the meantime one should consider the nature of the fixed sources in the region. With the exception of the PETROBRAS industrial complex in Cabiúnas, some 19 km from the site, there is virtually no significant fixed fossil fuel burning sources in the area. This indicates that background concentrations of interest to this project are typically rural to suburban and that kerb-side BR-101 concentrations are not applicable as baseline to evaluate the impact on sensitive areas. It should be noted that typical unpolluted ambient air has between 7.5 and 9.4  $\mu\text{g}/\text{m}^3$  of NO<sub>2</sub>.

According to the UK extensive 1993 to 1995 NO<sub>x</sub> survey in urban areas, typical urban background annual average concentrations reached 29  $\mu\text{g}/\text{m}^3$  UK ("UK Nitrogen Dioxide Survey, 1995, DOE, Executive Summary"), while 1-hour maximum concentrations ranged from 150 to 500  $\mu\text{g}/\text{m}^3$ . IAP, the State of Paraná environmental authority, and the Curitiba Municipality, sponsored NO<sub>x</sub> measurements in the Curitiba Metropolitan Region for stations located in industrial and suburban/rural locations, with results for 1 hour and annual urban background values similar to the UK study, while the measurements by CETESB in São Paulo

show generally higher values for the annual averages than the UK survey<sup>1</sup>. Typical US suburban and rural background concentrations are similar, though recorded peak concentrations in Los Angeles have historically reached as much as 7000  $\mu\text{g}/\text{m}^3$  (see Peavy. H.S. et al, “ Environmental Engineering”, McGraw-Hill International Editions, 1985). The figures are somewhat similar in spite of the basic difference between Brazil and countries like the US and UK, i.e. the intensive use of fossil fuels for electricity generation in the latter.

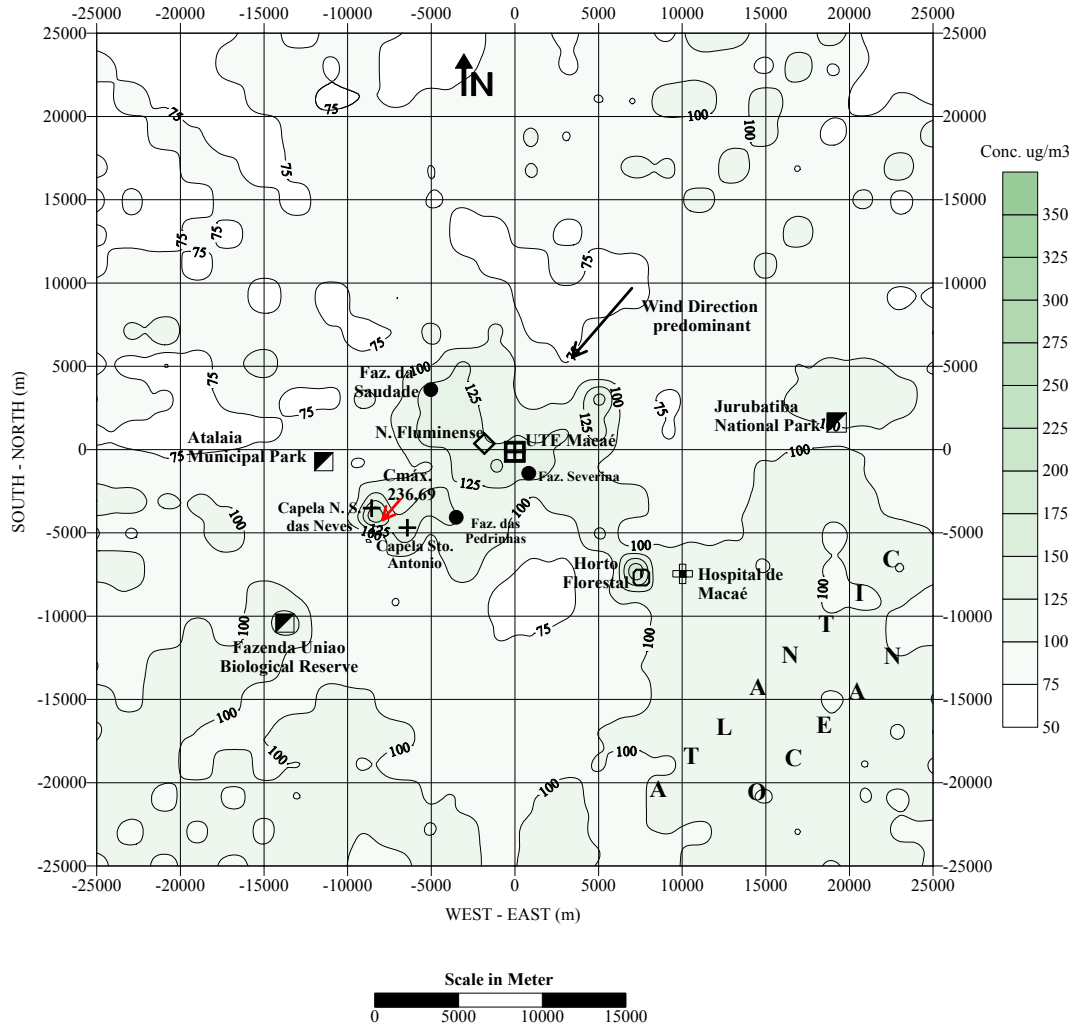
Assuming that the industrial development process of the Macaé region will induce further urban and industrial development so that typical suburban  $\text{NO}_2$  background concentrations are reached in the sensitive areas, the results of the present study show that only short term 1 hour maximum  $\text{NO}_2$  concentrations may reach levels close to the regulated Brazilian limit, considering background concentrations from all other fixed and mobile sources and the combined operation of Macaé Merchant and UTE Norte Fluminense. Considering the conservative nature of the estimates of Gaussian type dispersion models this is, however, not likely to occur.

A continuous AQ monitoring system for the indicated sensitive areas is, of course, under implementation.

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<sup>1</sup> References: CETESB, annual report, 2000; Municipality of Curitiba/LACTEC annual report, 2000; IAP – AQ annual report, 2000.

**MACAÉ MERCHANT PLUS THE EXPANSION AND NORTE FLUMINENSE PLANTS**  
**Isoconcentrations of Nitrogen Oxides, NO<sub>x</sub>, 1- hour average**  
**Maximum Concentration NO<sub>x</sub> (1 h) = 236.69 ug/m<sup>3</sup>**  
**Air Quality Standard for NO<sub>2</sub> (1h) = 320 ug/m<sup>3</sup>**



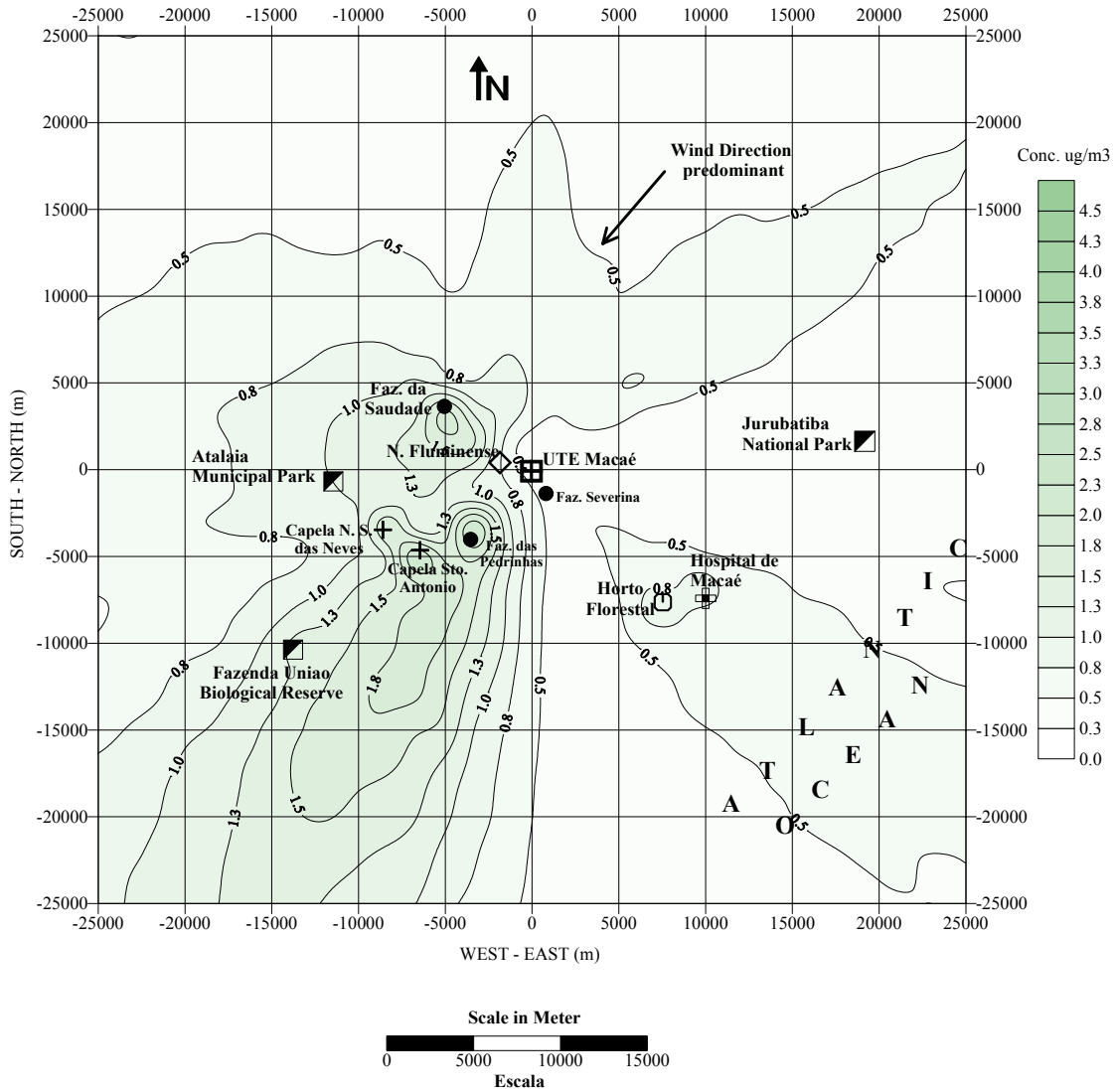
**Figure 3 – Isoconcentrations of Nitrogen Oxides, NO<sub>x</sub>, 1-hour average, resulting from emissions by Macaé Merchant plus the Expansion and Norte Fluminense operating simultaneously.**

**MACAÉ MERCHANT PLUS THE EXPANSION AND NORTE FLUMINENSE PLANTS**

**Isoconcentrations of Nitrogen Oxides, NO<sub>x</sub>, annual average**

**Maximum Concentration NO<sub>x</sub> (annual) = 4.3 ug/m<sup>3</sup>**

**Air Quality Standard for NO<sub>2</sub> (annual) = 100 ug/m<sup>3</sup>**



**Figure 4 – Isoconcentrations of Nitrogen Oxides, NO<sub>x</sub>, annual average, resulting from emissions by Macaé Merchant plus the Expansion and Norte Fluminense operating simultaneously**

## 11. References

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**SECTION 9**

**GREENHOUSE GAS EMISSIONS ASSESSMENT**

## SECTION 9

### GREENHOUSE GAS EMISSIONS ASSESSMENT

Assuming that the Macaé Merchant Plant operates at 40% capacity factor (3,000 GWh/year), at an average thermal efficiency of 35% in a simple cycle regime, the plant is expected to consume around 1 billion m<sup>3</sup> of gas per year, emitting about 1.8 million metric tons of CO<sub>2</sub> per year (using USEPA AP-42 current emission factor of 110 lb/MMBtu heat input), equivalent to about 0.6% of Brazilian National CO<sub>2</sub> emissions in 1998 (295,86 million t-CO<sub>2</sub>/year). The capacity factor and emissions will of course vary depending on the wholesale electricity market.

**SECTION 10**

**ARCHEOLOGICAL AND CULTURAL PROPERTIES**

## **SECTION 10**

### **ARCHEOLOGICAL AND CULTURAL PROPERTIES**

As explained in the executive summary, the procedures followed by El Paso have complied with both Brazilian strict regulations about historical and archeological heritage and WB policy (World Bank Operational Note Nr. 11.03 Management of Cultural Property in Bank Financed Projects).

A team of experts who analyzed other baseline surveys and studies for the EIA exercise visited the power plant site and the pipeline route. The site itself was found to possess no potential for pre-Colombian artifacts.

**SECTION 11**

**ENVIRONMENTAL COMPENSATION PROJECTS**

## SECTION 11

### ENVIRONMENTAL COMPENSATION PROJECTS

Environmental compensation projects, financed by El Paso, focus on meeting Brazilian legal requirements, as well as addressing local community needs as expressed through the public consultation process.

Requirements for the Macae Project were outlined in the Preliminary (PL) and Installation Licenses (IL). As a result, eight environmental compensation projects were created as listed below:

- Support to Conservation Units - Desengano State Park and the Concórdia State Park.
- Reforestation of riverbanks and springs of the Macaé River Basin.
- Master Plan for the Macaé River Estuary.
- Recovery of the Banks of the Macaé River – Campos Channel.
- Study of the Water Resources of the Macaé River Basin.
- Groundwater Survey.
- Environmental Education.
- Inventory of Atmospheric Emissions in the State of Rio de Janeiro.

By September 2001, agreements were signed between El Paso and the State of Rio de Janeiro Environmental Department (SEMADS) and related state environmental regulatory agencies, such as the State Forestry Institute (IEF), the Water Resources Agency (SERLA), the Mineral Resources Department (DRM), and the State Environmental Regulatory Agency (FEEMA), the licensing authority for the State of Rio de Janeiro.

An amount of R\$ 8,400,000.00 (eight million, four hundred thousand Real) was set aside for project implementation. That amount is approximately 1% of the total project investment (400 million dollars), an equivalent to double of the amount required by legislation, which is a minimum of 0.5% of the total project value.

Later, three projects, the Concórdia State Park, the Environmental Education Program, and the Atmospheric Emissions studies for the State of Rio de Janeiro, were later eliminated by the state agencies, so that a greater portion of available funds could be allocated for the Desengano State Park project.

Regardless of this state decision, El Paso believes in the value of environmental education initiatives, and decided to give an amount of R\$ 310,000.00 (three hundred and ten thousand Real) to be voluntarily invested in Environmental Education Programs. The goal of those programs is increasing the level of environmental awareness of the Macaé community and meeting the objectives of the compensation programs.

Compensation programs in progress or to be implemented over the coming three years, are divided into three groups:

- **Preservation of the Atlantic Forest**
  - Desengano State Park.
- **Preservation of the Macaé River**
  - Study of the Available Water Resources in the Macaé River Basin.
  - Groundwater Survey.
  - Reforestation of Riverbanks and Springs in the River Macaé Basin.
- **Revitalization of the Macaé River Estuary**
  - Management Plan for an Environmentally Protected Area (APA) for the Macaé River Estuary
  - Recovery of Canal Banks in the Mangrove Area.

**GROUP 1 – THE PRESERVATION OF THE ATLANTIC FOREST**

<b>1. Project Title:</b>  <i>Desengano State Park</i>	<b>Regulation #</b>  Nr. 24 of IL Nr.125/2001
<b>Investment:</b>  R\$ 5,000,000.00	<b>Implementation Period:</b>  3 years

**Project Description**

The on-going degradation of the forested areas of the Macae region, where the Desengano Park is located has accelerated the processes of soil desertification, erosion, and deterioration of fresh water springs. This situation has also contributed to economic decline in the region, due to increasingly limited natural resources.

A lack of consistent accountability and supervision by the conservation unit has hampered effective enforcement of existing preservation laws. Also, a poor level of community commitment and involvement continues to be a major deterrent to forest conservation.

This project aims at improving management of the conservation unit and developing projects that provide incentives for community participation, while improving the general use of and appreciation for the Desengano Park by local residents.

**Status**

The Brazilian Foundation for the Conservation of Nature (FBCN), a civil organization with 40 years experience in the environmental field, will be responsible for implementing the project. In January 2002, remodeling began for the headquarters for Firefighting and Fire Prevention and the temporary headquarters of the IEF (State Forest Institute). Equipment has been acquired for the firefighting teams and technicians of the IEF. Project teams are meeting together with the authorities to implement the environmental education initiatives.

**GROUP 2 – THE PRESERVATION OF THE MACAÉ RIVER**

<p align="center"><b>1. Project Title:</b></p> <p align="center"><i>Study of the Available Water Resources in the Macaé River Basin</i></p>	<p align="center"><b>Regulation #</b></p> <p align="center">Nr. 23 of IL Nr.125/2001</p>
<p align="center"><b>Investment:</b></p> <p align="center">R\$ 270,000.00</p>	<p align="center"><b>Implementation Period:</b></p> <p align="center">6 months</p>

**Project Description**

The objective of this program is to develop research projects that will increase the level of information about available water resources in the river Macaé basin where the Macaé Merchant Plant is located.

As indicated in the EIA, the available flow in the Macaé River is sufficient to meet consumer needs in the basin area. In an effort to address concerns about future water availability, El Paso is interested in water utilization and is developing the following studies on the basin as a whole:

- Survey of existing water users of the Macaé River.
- Evaluation of future demands for water supply.
- Study to regionalize flows, in particular to evaluate minimum flows.
- Verification of current users and identification of expectations regarding the future classification of the Macaé River.
- Evaluation of water resources.

**Status**

Upon project initiation, meetings were held between representatives of El Paso and SERLA / FEEMA, during which details of a work plan were outlined and the specific methodology to be used was determined. An initial status report was prepared and future activities were scheduled.

**GROUP 2 – THE PRESERVATION OF THE MACAÉ RIVER**

<b>2. Project Title</b> <i>Groundwater Survey</i>	<b>Regulation #</b> Nr. 18 of IL Nr.125/2001
<b>Investment:</b> R\$ 180,000.00	<b>Implementation Period:</b> 18 months

**Project Description**

The objective of the project is to develop studies to increase the level of information about the potential availability of groundwater in the state of Rio de Janeiro and in the Macae River basin. An area of 30 km<sup>2</sup> of groundwater is being analyzed in coordination with the Mineral Resources Department (DRM) of the state of Rio de Janeiro, so that results can effectively be included in the state’s planning process.

The studies will include the following activities:

- Baseline data collection.
- Identification of water supply sources, description of physical characteristics, flow rates, aquifers, water use, and chemical quality.
- Survey of morphological-tectonic and litho-stratigraphic domains, aimed at describing the potential of aquifers, based on photo-interpretation and analysis of digital images.
- Assessment of aquifers vulnerability to contamination.
- Sampling of physical, chemical, and bacteriological parameters.

**Status**

This project is underway and the preliminary studies have been completed. The first progress report has been prepared and includes compilation and analysis of the basic data gathered.

**GROUP 2 – THE PRESERVATION OF THE MACAÉ RIVER**

<p align="center"><b>3. Project Title:</b></p> <p align="center"><i>Reforestation of Riverbanks and Springs in the River Macaé Basin</i></p>	<p align="center"><b>Regulation #</b></p> <p align="center">Nr. 21 of IL Nr.125/2001</p>
<p align="center"><b>Investment:</b></p> <p align="center">R\$ 1,250,000.00</p>	<p align="center"><b>Implementation Period:</b></p> <p align="center">18 months</p>

**Project Description**

The objective of the project is to reforest the area by planting native seedlings in the degraded sections of the riverbanks in the Macaé River basin.

The reforestation initiative focuses on the margins of watercourses and springs. It includes maintenance and improvement of the water sources in the river basin, with the additional benefit of offsetting the overall impact of CO<sub>2</sub> emissions.

Areas to be reforested will be identified, selected, and coordinated with the water agency (SERLA).

**Status**

The implementation of this project will be designated to a local organization to be determined by SEMADS. The technical proposal will describe the scope of the project and will be prepared with representatives of the IEF.

**GROUP 3 – REVITALIZATION OF THE ESTUARY OF THE MACAÉ RIVER**

<p><b>1. Project Title:</b></p> <p><i>Management Plan for an Environmentally Protected Area (APA) for the Macaé River Estuary</i></p>	<p><b>Regulation #</b></p> <p>Nr. 21 of IL Nr.125/2001</p>
<p><b>Investment:</b></p> <p>R\$ 200,000.00</p>	<p><b>Implementation Period:</b></p> <p>6 months</p>

**Project Description**

An extensive mangrove with numerous small canals is an environmental resource of significant importance to the biodiversity and environmental quality of the areas associated ecosystems.

The Macaé River estuary has been subjected to various kinds of degradation such as: deforestation, sprawling squatter communities, clandestine landfills, and pollution from sewage and garbage deposited by the population settlements developing around the swamp.

The municipality has expressed a specific desire to rehabilitate this area. As a priority, it has allocated funds to relocate and prevent some of the squatter communities, while providing suitable infrastructure for some of the neighboring settlements in order to better protect the environment.

To tackle this problem, the municipality of Macae recently established a program to rehabilitate and control the population growth of the Leocádia Island Colony. In addition to the island colony, a great deal of revitalization is still required, however, in the remaining mangrove areas.

For this reason, the state environmental regulatory agency, in response to recommendations by the Macaé City Hall, decided to continue the preservation

plans for the mangrove, which would focus on the areas outside the Leocadia Island. The agency made this a requirement for the compensation programs to be carried out for the Macaé Merchant Plant. The program will be based on existing guidelines for creating Environmentally Protected Areas (APA).

## **Status**

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This project is in progress and is being implemented by Ecologus Engenharia Consultiva Ltda. Some of the basic surveys on land use, population settlement patterns, and vegetation analysis have already been completed. In addition, a demographic survey was carried out with the Municipality of Macaé.

The boundaries for the future protected area have been defined. However, this is a preliminary proposal, which will require more in-depth studies. Discussions will be held with local interest groups, including association representatives and NGOs to obtain their input on the project.

Proposals to define the boundaries of the protected area will be developed using input from the public consultation process. All stages of the project, including zoning and development of a Master Plan, will focus on the preservation and rehabilitation of the mangrove as well as improve the general quality of life of the local population.

**GROUP 3 – REVITALIZATION OF THE ESTUARY OF THE MACAÉ RIVER**

<p><b>2. Project Title:</b></p> <p><i>Recovery the Canal Banks in the Mangrove Area</i></p>	<p><b>Regulation #</b></p> <p>Nr. 22 of IL Nr.125/2001</p>
<p><b>Investment:</b></p> <p>R\$ 1,500,000.00</p>	<p><b>Implementation Period:</b></p> <p>1 year</p>

**Project Description**

The objective of this project is to take environmental remediation measures on a 1,000-meter section of a canal bank located within the mangrove at the mouth of the Macaé River, and a 250-meter section of the bank of the Macaé-Campos channel. Both sections, in the Nova Holanda district, are being destroyed by the advancement of dwellings on the riverbank and into the flood plains of both channels. These sprawling settlements are placing the channels and the mangroves located on the opposite bank at great risk.

Even though the area is included in the Macaé Estuary, the proposed intervention requires an emergency initiative to quickly reduce the channel degradation. The project includes the building of retaining structures along the settled banks of the Macaé-Campos and Macae river channels, over a length of approximately 1,250 meters.

The project will be coordinated by the Macae government and will include the installation of a sewage system to be constructed along the channel banks.

**Status**

The project is underway. Contacts were made with local authorities and the community to integrate the project within the program to revitalize the Macaé River Estuary. Integrated studies for the construction projects and the riverbank retaining structure have been completed. The first technical report characterizing the works area has been completed and approved by the government organizations involved including: the Macaé City Hall, SERLA and SEMADS.

**EL PASO'S ENVIRONMENTAL EDUCATION  
VOLUNTARY PROGRAMS**

## EL PASO'S ENVIRONMENTAL EDUCATION VOLUNTARY PROGRAMS

In line with its commitment to being a socially responsible citizen, El Paso voluntarily decided to sponsor two additional social programs, which were not required by law through the environmental licensing process. One program is an environmental education program with the goal of increasing community awareness of the importance of preserving the environment. The other is a health education program aimed at improving the health and hygiene practices of local communities.

The main goal of the voluntary environmental program to be sponsored by El Paso is to promote a sense of citizenship and responsibility, by making the community aware of causes and effects associated with degradation of the environment and understand how a polluted environment negatively affects their quality of life. In general, it is hoped that the program participants become better equipped to take a leadership role in influencing others in better managing natural resources and become aware of the importance of preservation. The program also seeks to establish mechanisms to train young people who participate in the program to act as environmental agents within their various communities.

The health education program focuses on both treatment and training and education of community participants. The program has many components, which include: research, training, community building, education, and treatment. Children serve as the target group for the core educational component, as well as treatment. Teachers are trained and provided with lesson plans on specific health topics. Community events are organized to expose parents to relevant health topics and create a level of overall community awareness of the importance of health and hygiene.

**VOLUNTARY ENVIRONMENTAL EDUCATION PROGRAMS**

<b>1. Project Title:</b> <i>Environmental Education Program</i>	<b>Regulation #</b> <i>Voluntary Program</i>
<b>Investment:</b> R\$ 250,000.00	<b>Implementation Period:</b> 10 months

**Project Description**

The environmental education program to be implemented by the Macaé Merchant Plant is designed to benefit those who reside in the influence area of the project. This will be a voluntary investment made by El Paso to complement the other environmental compensation programs sponsored by the project.

Planning for Environmental Education Program focused on the community. The program is designed to help the community become better equipped to manage its natural resources and become aware of the importance of their preservation.

This program focuses on the more needy communities located in the area at the mouth of the Macaé River, since they are most vulnerable to the social-environmental changes planned by the municipal government. The migration to the area by many people in search of job opportunities led many families to build their homes in environmentally fragile areas, which lack sanitary infrastructure and urban facilities. These settlements have been progressively advancing into the mangrove and floodplain areas, making infrastructure development very complicated.

The object of Environmental Education is to develop citizenship, by making the community aware of causes and effects associated with contamination of the environment and how pollution leads to a decline in the quality of life. Young people from the community will be trained to be taking a leadership role in helping others become more aware of the importance of environmental preservation.

## **Status**

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This project will be carried out in partnership with El Paso, the Macae Environmental Department, and the NGO, the Center for Culture, Information and Environment (CIMA). The Municipal Education and Social Action Departments will also be involved in the activities to train young people and adults involved in the project. An official cooperative agreement will be signed between El Paso and the municipality of Macae to implement the project.

**VOLUNTARY ENVIRONMENTAL EDUCATION PROGRAMS**

<p align="center"><b>2. Project Title:</b></p> <p align="center"><i>“Produzindo Saúde” – Environmental Education Program</i></p>	<p align="center"><b>Regulation #</b></p> <p align="center"><i>Voluntary Program</i></p>
<p align="center"><b>Investment:</b></p> <p align="center">R\$ 60,000.00</p>	<p align="center"><b>Partnership</b></p> <p align="center">El Paso &amp; INMED</p>

**Project Description**

Another voluntary program implemented by El Paso in the communities located in the Macaé river estuary area, as part of the Environmental Education Program, will be the Health Generation Project (“Produzindo Saúde”).

Since 1999, El Paso and INMED have been working together in Brazil to develop the Health Generation Project. The project first started in Manaus, Amazonas State, providing a better quality of life for 2000 children of the Osmar Pedrosa State School.

After a year of great success, in the year 2000, El Paso decided to also implement the project in Porto Velho (State of Rondônia, Brazil) to assist 10,000 children and in Manaus (Amazonas) to reach 5000 children in different schools. Today, El Paso and INMED are helping a total of 15,000 children in Brazil.

Since then, the Health Generation Project has become an integral part of lives of community residents by providing health, training, education, and social integration.

## **HEALTH GENERATION PROJECT**

The Health Generation Project is part of the Children as Agents of Change (CAC) program by INMED, designed to control and prevent disease by targeting the most vulnerable segment of the world's population: children. Its strategy integrates three elements into a comprehensive program that inspires and enables children to become powerful agents of change among their peers, families, and communities:

- *Treatment*: treating children for preventable diseases and conditions,
- *Education*: educating children about how to prevent and control disease, and
- *Action*: empowering children to take action to bring about better health in their families and communities.

The project encompasses six key components – baseline research, training, community support building, treatment, health education and evaluation – each of which is described below.

- **Baseline Research**

Biomedical examinations and simple surveys that measure knowledge and understanding of the factors that cause disease indicate the baseline conditions in project communities.

- **Training**

Project staff and teachers regularly attend workshops and refresher courses on the CAC strategy and participatory education methodology. Workshop topics also include: technical information on parasites, Vitamin A and Iron supplementation, field management of the project, and the parent role in improving the health of their children. Each month, teachers receive a packet of information with the targeted health topic and a guide on how to teach the related lessons through a series of games, activities and homework assignments.

- **Building Community Support**

At the beginning of the project, staff and teachers design a campaign to increase community awareness of the project and gain parental approval and support. The community relations are developed through a series of community meetings and events. For example, on days that children receive medicine for worms, the benefits of vitamin supplements are presented to the whole community. This is usually done in the context of a social event that includes music, refreshments, and entertainment. During the school year, children stage plays and costume parades to promote the benefits of good hygiene and improved sanitation practices.

- **Treatment**

Twice each year, participating children and their family members are treated with a powerful, but safe worm medication administered under the supervision of a medical professional. For the children most severely affected by parasitic infection, the results of treatment are dramatic. Within just a few days, children who were sick, lethargic, and disinterested as a result of their infections showed renewed health, energy and enthusiasm. INMED also administers Vitamin A and Iron supplements, since parasites reduce the body's ability to absorb these vital nutrients. Vitamin A deficiencies can lead to blindness, and lack of Iron can compromise immune functions, and delay growth and development.

- **Health Education**

The baseline research data collected on the participating communities serves as a needs analysis and determines which health, hygiene, and sanitation topics should be addressed. Working with one or two of these basic health topics each month, teachers and children combine classroom lessons on prevention and control of disease with participatory activities such as posters, games, songs, plays and parades that illustrate the concepts they learn.

- **Evaluation**

Many changes in personal and community hygiene and sanitation, as well as the improved health of children and families have been observed as a result of the program. However, to fully evaluate changes and the effectiveness of the health education strategy needs assessments and evaluations are regularly conducted. This information is then used to make program adjustments and improvements, as well as to plan programs for other regions.

**ANNEX**

**ENVIRONMENTAL PERMITS**



Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

**FEEMA - Environmental Engineering State Foundation**

**PREVIOUS LICENSE**

**PL Nr. 013/2001**

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As per Deliberation No. 003, of 12/28/77, by the State Committee for Environmental Control – CECA, the Environmental Engineering State Foundation – FEEMA, according to the powers granted to it by Decree-Law No. 134, of June 16, 1975, Article 8, and according to the Polluting Activity License System, established by Decree No. 1633, of December 21, 1977, hereby issues this Previous License, which authorizes

Company: EL PASO RIO CLARO LTDA.  
CNPJ/CPF: 02.290.787/0001-07  
Address: Praia de Botafogo No. 440 – 14º andar – Botafogo  
Adm. Reg/District Court: 6<sup>th</sup> RA – Botafogo  
Municipality of Rio de Janeiro, State of Rio de Janeiro, registered in FEEMA under code 10009420/35.11.10, to develop implementation studies regarding the activity(ies) of natural gas Thermoelectric power plant. x-x-x-x-x-x-x-x-

Located at: Highway BR-101, km 169 – Sítio Severina – Barra de Macaé, municipality of Macaé.

with the following restrictions:

1. Comply, within thirty (30) days, counting from the date of issuance of this License, with NA-052 – Regulation for Issuance of Obligatory Licenses and Environmental Impact Study for the Polluting Activity License System, approved by Deliberation CECA No. 2538, of 11/12/91 (Official Gazette of. 12/06/91) sending copy of issues to FEEMA, within the same term.
2. This License refers to environmental aspects and does not exempt the entrepreneur from complying with the other aspects required by law.
3. This License shall not be amended, in any way, nor plastic-coated, under penalty of losing its validity.

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This PL shall be effective until March 13, 2003, counting from the date hereof, as FEEMA Proceeding No. E-07/201.895/00, in compliance with the conditions set forth in this documents and its annexes, which although not transcribed herein shall be an integral part hereof.

Rio de Janeiro, March 13, 2001.

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AXEL SCHMIDT GRAEL  
President of FEEMA

*The construction, reform, extension, installation or operation of potentially polluting establishments, works or services, in violation to the applicable legal standards and regulations or non-compliance with legal or contractual obligation of relevant environmental interest may imply the crimes set forth in articles 60 and 68 of Act No. 9.605, of 02.12.98, and the violator, as an individual or a legal entity, shall be subject to the penalty of detention or payment of a fine.*

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## **RESTRICTIONS TO THIS PL**

4. This License does not authorize the start-up of works;
  5. The documents listed below shall be presented when applying to this Installation License:
    - 5.1 Executive project and descriptive memorial regarding the plant erections, with layout;
    - 5.2 Executive project and descriptive memorial regarding the pluvial drainage system: network tracing and disposal spots;
    - 5.3 Executive project and descriptive memorial regarding the sanitary sewing: treatment units and types, disposal spots;
    - 5.4 Executive project and descriptive memorial of the water supply system: structures involving the collection, adduction and disposal;
    - 5.5 Water collection plan of River Macaé, including CEDAE's Supply Leading Plan and the supply of the cities of Rio das Ostras and Barra de São João;
    - 5.6 Executive project and descriptive memorial concerning the job site infrastructure: layout, drainage system, sanitary sewing system, and water supply system;
    - 5.7 Executive project and descriptive memorial concerning the treatment of liquid effluents, including waste inventory and description of the final destination foreseen;
    - 5.8 Landscaping project, including the use of native vegetal species;
    - 5.9 Executive project and descriptive memorial including the constructive methods for implementing the natural gas distribution line;
    - 5.10 Executive project and descriptive memorial including the constructive methods for implementing the electric power transmission line;
    - 5.11 Earthmoving executive project, with volume and cross-section cuts;
    - 5.12 Specific project for sound insulation of the turbines, so as to ensure the noise issuance level provided for by law;
    - 5.13 Research project and archeological survey concerning the gas pipeline tracing areas and the Thermoelectric Power Plant implementation site;
    - 5.14 Project for temporary disposal of smudge, considering the need of ground sealing and a suitable drainage system;
    - 5.15 Project for decomposition of the Protection Limit Stretch – FMP and recomposition of riverbeds at the intervention areas, adjusting the areas to the programs already under progress at the enterprise area – “Our Tree Program”;
    - 5.16 Handling plan, aiming at extending the studies on the Growth of Mangroves Protection Unit of the River Macaé estuary;
    - 5.17 Project for recovery of the collecting channel margins, located inside the growth of mangroves area, within a stretch of 1,000 m and another, of 250 m, from the channel of Macaé – Campos, in the borough of Nova Holanda;
    - 5.18 Water quality monitoring program on the River Macaé, upstream and downstream from launching of the Thermoelectric Power Plant, including half-year reports with data provided in digital media (sampling data in Microsoft ACCESS (.mdb) or EXCEL spreadsheet (\*.xls), with fields and descriptions according to the model to be
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Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

## **FEEMA - Environmental Engineering State Foundation**

### **PREVIOUS LICENSE**

**PL Nr. 013/2001**

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Company: EL PASO RIO CLARO LTDA.

Located at: Highway BR-101, km 169 – Sítio Severina, municipality of Macaé.

### **RESTRICTIONS TO THIS PL**

- supplied by FEEMA, indicating the laboratory methods used for the analyzes, accompanied by analyzes and interpretation of results to be submitted to the Water Quality Division – DIAG for analysis and approval. This program shall include biological indicators that may identify potential impacts to the biota, arising from temperature variations in the water body, and the discharge shall not cause increase of temperature in the recipient body higher than 2oC;
- 5.19 Air quality monitoring program and meteorological parameters, starting at the enterprise start-up, from the preparation of the area and continuing during its operation, including the continuous monitoring, with treatment and availability of the generated information, in real time, for FEEMA's Air Quality Data Center, to be submitted to the Air Quality Division – DIAR, for analysis and approval;
  - 5.20 Continuous monitoring program of atmospheric emissions, with treatment and availability of the generated information, in real time, for FEEMA's Air Quality Data Center, to be submitted to the Air Quality Division – DIAR, for analysis and approval;
  - 5.21 Noise level monitoring program;
  - 5.22 Monitoring program of soil and underground waters;
  - 5.23 Solid waste monitoring program (sludge composition);
  - 5.24 Monitoring program for the transmission line: soils and erosive processes;
  - 5.25 Risk Management Program – PGR, of the Thermoelectric Power Plant and the dedicated pipeline (operating and implementation track), including a continuous program of inspections of maintenance and training of operators, aiming at guaranteeing their efficiency;
  - 5.26 Study of "Hydric Availability of River Macaé Basin", including all effluents through its outfall into the Atlantic Ocean, focusing, at least, the following aspects: current and future usages of the Basin waters, considering the farming potential and local administrations interest, rationalization study of minimum flows and assessment of hydric availability of water bodies in classes according to the intended uses. The studies shall be analyzed by FEEMA's and SERLA's technicians;
  - 5.27 Underground water research project, including the proposal prepared by the Mineral Resources Department – DRM, of the Energy, Naval Industry and Petroleum Department;
  - 5.28 Social communication and environmental education program, consistent with the government programs under progress in the State, that is, the environmental education project – "Verde que te Quero Verde", by the State Department of Environment and Sustainable Development – SEMADS;
  - 5.29 Support program to Protection Units, in compliance with CONAMA Resolution No. 02/96 and Act No. 9.985/00, Article 36, item 1, depending of definition of conservation units to be benefited or the creation of a new UC and the understandings with SEMADS;
  - 5.30 Project including the proposal of the Brazilian Institute of Environment and Renewable Natural Resources – IBAMA, in compliance with the existing law, aiming at environmental compensation measures for the

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Rio de Janeiro, March 13, 2001

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President of FEEMA

*The construction, reform, extension, installation or operation of potentially polluting establishments, works or services, in violation to the applicable legal standards and regulations or non-compliance with legal or contractual obligation of relevant environmental interest may imply the crimes set forth in articles 60 and 68 of Act No. 9.605, of 02.12.98, and the violator, as an individual or a legal entity, shall be subject to the penalty of detention or payment of a fine.*

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## **RESTRICTIONS TO THIS PL**

National Park of Jurubatiba Sandbank, in the event the dedicated gas line to the Thermoelectric Power Plant from the Cabiúnas Station is build;

6. Previously submit to FEEMA, for analysis and opinion, any change to the data and projects presented;
7. The projects regarding the provisions set forth in CONAMA Resolution No. 02/96, which shall total 0,5% of the total costs estimated for the implementation of the enterprise;
8. The projects regarding the provisions set forth in Act No. 9.985/00, which shall total 0,5% of the total costs estimated for the implementation of the enterprise.x-x-x-x-x-x-x-x-x-x-x



**GRANTS TO EL PASO RIO CLARO LTDA. THE RIGHT TO USE THE WATER RESOURCES OF THE MACAÉ RIVER, AS SHOWN BELOW**

THE GOVERNOR OF THE STATE OF RIO DE JANEIRO, in the exercise of his legal powers and in view of the terms of sub item XIX of article 21 of the Federal Constitution, Federal Law n° 9433, of January 8, 1997, and State Law n° 3239, of August 2, 1991, and bearing in mind the records of Case n° E-07/101373/2000

DECREES:

**Art. 1** - The right to use of the water resources is granted to El Paso Rio Claro Ltda., having its head office in the city of Rio de Janeiro, at Praia de Botafogo, n° 440, 10th floor (part), Botafogo, registered in the Corporate Taxpayers' Register - CGC under n° 02.290.787/0001-07, for a period of 10 (ten) years, as below:

a) to impound water from the Macaé river at a maximum rate of 86 l/s (eighty-six liters per second), 24h/day (twenty-four hours a day), at the following geographic coordinates

Latitude - 22° 17' 41" S  
Longitude - 41° 52' 52" W

b) to discharge liquid waste at a maximum of 12 l/s (twelve liters per second), 24h/day (twenty-four hours a day), while complying with the restrictions imposed by the State Environmental Engineering Foundation - FEEMA, at the following geographic coordinates

Latitude - 22° 17' 41" S  
Longitude - 41° 55' 55" W

**§ 1** - Water should be impounded upstream of the point at which liquid waste is discharged by the Concession Holder, in accordance with Law No 3239/99, art. 22, § 2.

**Art. 2---** The Concession Holder should install and keep in working order the measuring equipment for continuous monitoring of the volume of water impounded and discharged.

**Art. 3** - The concession for use hereby granted will be partially or totally suspended or revoked at any time, irrespective of indemnity, under the circumstances mentioned in art. 24 of Law No 3239/99, if the respective environmental license is rejected or annulled, and also if the public interest, with due grounds, so demands.

**Art. 4** - Any change in the volume of water to be impounded in accordance with article 1 of this decree and/or any change of concession holder will require a new concession for use, the text of which is laid down by article XX of State Law number 3239/99.

**Art. 6** - The terms and conditions of this concession for use will be adapted, as applicable, to the priorities established in the latest Water Resources Plan for the Hydrographic Basin to which the water course covered by this concession belongs, and to the provisions of the regulation of Federal Law No 9433/97 and State Law No 3239/99.

**Art. 7** - The effect of this concession of the right to use is conditional

- a) upon the prior approval, by the State Superintendence of Rivers and Lagoons - SERLA of the basic engineering project for impounding the water and compliance with other applicable conditions of that type imposed by that Foundation
- b) prior concession, by the State Environmental Engineering Foundation - FEEMA of the applicable environmental license, in accordance with the pertinent legislation.

**Art. 8** - The concession holder will have civil, penal and administrative responsibility for damage caused to life, health or the environment and for any inappropriate use of this concession, in accordance with the pertinent legislation.

**Art. 9** - this decree will come into effect on the date of its publication, all provisions to the contrary being revoked.

Rio de Janeiro, September 14, 2001

ANTHONY GAROTINHO

Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

**FEEMA - Environmental Engineering State Foundation**

**INSTALLATION LICENSE**

**IL Nr. 089/2001**

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As per Deliberation No. 003, of 12/28/77, by the State Committee for Environmental Control – CECA, the Environmental Engineering State Foundation – FEEMA, according to the powers granted to it by Decree-Law No. 134, of June 16, 1975, Article 8, and according to the Polluting Activity License System, established by Decree No. 1633, of December 21, 1977, hereby issues this Installation License, which authorizes

Company: EL PASO RIO CLARO LTDA.  
CNPJ/CPF: 02.290.787/0001-07  
Address: Praia de Botafogo No. 440 – 14º andar – Botafogo  
Adm. Reg/District Court: 4<sup>th</sup> RA – Botafogo  
Municipality of Rio de Janeiro, State of Rio de Janeiro, registered in FEEMA under code 10009420/33.61.25, to develop earthmoving works required for the implementation of the thermoelectric power plant. x-x-x-x-x-x-x-x-

Located at: Highway BR-101, km 169 – Sítio Severina – Barra de Macaé, municipality of Macaé.

with the following restrictions:

1. Comply, within thirty (30) days, counting from the date of issuance of this License, with NA-052 – Regulation for Issuance of Obligatory Licenses and Environmental Impact Study for the Polluting Activity License System, approved by Deliberation CECA No. 2538, of 11/12/91 (Official Gazette of. 12/06/91) sending copy of issues to FEEMA, within the same term.
2. This License refers to environmental aspects and does not exempt the entrepreneur from complying with the other aspects required by law.
3. This License shall not be amended, in any way, nor plastic-coated, under penalty of losing its validity.

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This IL shall be effective until March 19, 2004, counting from the date hereof, as FEEMA Proceeding No. E-07/202.722/00, in compliance with the conditions set forth in this documents and its annexes, which although not transcribed herein shall be an integral part hereof.

Rio de Janeiro, March 19, 2001.

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AXEL SCHMIDT GRAEL  
President of FEEMA

*The construction, reform, extension, installation or operation of potentially polluting establishments, works or services, in violation to the applicable legal standards and regulations or non-compliance with legal or contractual obligation of relevant environmental interest may imply the crimes set forth in articles 60 and 68 of Act No. 9.605, of 02.12.98, and the violator, as an individual or a legal entity, shall be subject to the penalty of detention or payment of a fine.*

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## **RESTRICTIONS TO THIS IL**

4. This License refers to earthmoving works, in an area of 114,000 m<sup>2</sup>, with three (3) patamars and the construction of about 1,300 meters of access road for the implementation of the Thermoelectric Power Plant of Macaé Merchant at Serverina, next to the Highway BR-101, located in the 5<sup>th</sup> District of the municipality of Macaé;
  5. The job site shall have 9,600 m<sup>2</sup> and six (6) chemical toilets, the administrative department and the laboratory for physical tests of soil shall be installed in containers, and one (1) maintenance shop, one (1) lavatory, one (1) supply station and one (1) refectory;
  6. Store, in a suitable and protected place, the fertile layer of soil resulting from scouring for the execution of the earthmoving works, to be used later in the landscaping project, as well as in the recovery and protection against erosion of slopes and landfill areas, so as to avoid erosion and spreading. In the event the material is not used within a period higher than twelve (12) months, it shall be seeded in order to avoid erosion by rain and wind;
  7. Install, in the beginning of the works, as provided for in the construction plan, pluvial water collecting boxes at drainage spots, with volumetric capacity sufficient for pluvial accumulation, considering the sedimentation of soil and stubbles wastes;
  8. Build, in the beginning of the services, the inlets, with stabilized material for the control of sludge and powder and keep them in operating conditions during the whole time of the enterprise implementation, according to the specifications defined in the project;
  9. Use the landfills as structural material to be applied in the whole construction area;
  10. Protect, during the construction, the benches throughout its slopes by applying a protection blanket against erosion;
  11. Dispose all material in excess resulting from the earthmoving work in the very area of the enterprise, in compliance with the technical criteria of compacting and protection against erosive processes. The landfill height shall not exceed ten (10) and such areas shall be contemplated in the landscape project included in the Previous License;
  12. Keep the pluvial drainage, existing and built, permanently cleared of sediments;
  13. Install a cleaning device for the wheels of the vehicles so as to avoid the transportation of the earth material dirty the highway;
  14. Build drainage channels with energy dissipation devices;
  15. Evaluate, in the stage of application for the Production Unit Installation License, if the existing drainage system, connected to the old bed of River Macaé, has enough capacity to receive 3,5 m<sup>3</sup>/s of pluvial waters arising from the enterprise's drainage area, in limit conditions of rainfall;
  16. Keep the springs and the lake protected;
  17. Forward the wastewater resulting from cleaning of employees to a sewage/drain, considering that they shall not be lodged in the job site and chemical toilets shall be used;
  18. Use only formol-free disinfectants in the chemical toilets and the wastes resulting from cleaning thereof shall be discharged into the sewage treatment station – ETE of the Airport, pursuant to an authorization by the municipality;
  19. Send the solid wastes resulting from the enterprise activities to the sanitary embankment of Macaé;
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Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

**FEEMA - Environmental Engineering State Foundation**

**INSTALLATION LICENSE**

**IL Nr. 089/2001**

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Company: EL PASO RIO CLARO LTDA.

Located at: Highway BR-101, km 169 – Sítio Severina, municipality of Macaé.

**RESTRICTIONS TO THIS IL**

20. Pack the oil wastes resulting from exchanges and removed from water/oil separator, in suitable containers and sent them to refineries;
  21. Provide fuel storage tanks with water-proof protection dics, and with useful capacity equal to the storage tank, so as to hold any leakage;
  22. Comply with NR-202 R 10 – “Criteria and Standards for Disposal of Industrial Liquid Effluents”, approved by Deliberation CECA No. 1007, of 12.12.86;
  23. Comply with DZ-215 R 01 – “Biodegradable Organic Load Control into Liquid Effluent of Non-industrial Origin Guideline”, approved by Deliberation CECA No. 3154,of 04.26.94;
  24. Comply with DZ-1311 R 04 – “Waste Destination Guideline”, approved by Deliberation CECA No. 3327, of 11.29.94;
  25. It's not permitted the burn of any material outdoors;
  26. Avoid all kinds of accumulation of waters that may cause the proliferation of the mosquito “Aedes aegypt”, transmitter of Dengue.
  27. FEEMA shall demand new control measures, whenever it deem so necessary;
  28. Previously submit to FEEMA, for analysis and opinion, any extension and/or change to the project.
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Rio de Janeiro, March 19, 2001

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President of FEEMA

Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

**FEEMA - Environmental Engineering State Foundation**

**INSTALLATION LICENSE**

**IL Nr. 125/2001**

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As per Deliberation No. 003, of 12/28/77, by the State Committee for Environmental Control – CECA, the Environmental Engineering State Foundation – FEEMA, according to the powers granted to it by Decree-Law No. 134, of June 16, 1975, Article 8, and according to the Polluting Activity License System, established by Decree No. 1633, of December 21, 1977, hereby issues this Installation License, which authorizes

Company: EL PASO RIO CLARO LTDA.  
CNPJ/CPF: 02.290.787/0001-07  
Address: Praia de Botafogo No. 440 – 14º andar – Botafogo  
Adm. Reg/District Court: 6<sup>th</sup> RA – Botafogo  
Municipality of Rio de Janeiro, State of Rio de Janeiro, registered in FEEMA under code 10009420/35.11.10, to develop implementation studies regarding activity(ies) of natural gas Thermoelectric power plant. x-x-x-x-x-.

Located at: Highway BR-101, km 169 – Sítio Severina – Barra de Macaé, municipality of Macaé.

with the following restrictions:

1. Comply, within thirty (30) days, counting from the date of issuance of this License, with NA-052 – Regulation for Issuance of Obligatory Licenses and Environmental Impact Study for the Polluting Activity License System, approved by Deliberation CECA No. 2538, of 11/12/91 (Official Gazette of. 12/06/91) sending copy of issues to FEEMA, within the same term.
2. This License refers to environmental aspects and does not exempt the entrepreneur from complying with the other aspects required by law.
3. This License shall not be amended, in any way, nor plastic-coated, under penalty of losing its validity.

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This IL is effective until April 06, 2004, counting from the date hereof, as FEEMA Proceeding No. E-07/200640/01, in compliance with the conditions set forth in this documents and its annexes, which although not transcribed herein shall be an integral part hereof.

Rio de Janeiro, April 06, 2001.

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AXEL SCHMIDT GRAEL  
President of FEEMA

*The construction, reform, extension, installation or operation of potentially polluting establishments, works or services, in violation to the applicable legal standards and regulations or non-compliance with legal or contractual obligation of relevant environmental interest may imply the crimes set forth in articles 60 and 68 of Act No. 9.605, of 02.12.98, and the violator, as an individual or a legal entity, shall be subject to the penalty of detention or payment of a fine.*

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## **RESTRICTIONS TO THIS IL**

4. Accomplishment of the presented engineering projects, according to Basic Environmental Plan, in regard to:
    - 4.1 Buildings
    - 4.2 Pluvial drainage system: network tracing and disposal spots.
    - 4.3 Sanitary sewage system: treatment units and types, disposal spots.
    - 4.4 Treatment system of liquid effluents, including waste inventory and description of the final destination established.
    - 4.5 Job site infrastructure: layout, drainage system, sanitary sewage system, and water supply system.
    - 4.6 Raw water collection as to structural and hydraulic aspects, concerning the recovery of the Protection Limit Strip of Macaé River.
    - 4.7 Sound insulation of the turbines, so as to ensure the noise issuance level provided for by law.
  5. Water quality monitoring program on the Macaé River, upstream and downstream from launching of the Thermolectric Power Plant, including half-year reports with data provided in digital media (sampling data in Microsoft ACCESS (.mdb) or EXCEL spreadsheet (\*.xs), with fields and descriptions according to the model to be provided by FEEMA, indicating the laboratory methods used for the analysis, accompanied by analysis and interpretation of results to be submitted to the Water Quality Division – DIAG for analysis and approval. This program shall include biological indicators that may identify potential impacts to the biota, arising from temperature variations in the water body, and the discharge shall not cause increase of temperature in the recipient body higher than 2°C.
  6. Complementation of the proposed biological monitoring program with parameters that characterize the whole biota from Macaé river, including, in this case, phytoplankton and zooplankton indicators.
  7. Accomplishment of noise level monitoring campaigns, with presentation of biannual measurement reports containing: sound level measured in dB (A); noise length or, for variable levels, its statistic distribution; operational condition of noise source and prevailing climatic characteristics during measurements (winds' temperature, direction and speed); noise occurrence hour and of measurements; corrected sound level; measured background noise level; noise criterion value with corrections for the period (daytime or nighttime) and zone (residential, industrial, etc); sketches with localization of measurement spots.
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Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

**FEEMA - Environmental Engineering State Foundation**

**INSTALLATION LICENSE**

**IL Nr. 125/2001**

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Company: EL PASO RIO CLARO LTDA.  
Located at Praia de Botafogo No. 440 – 14º andar – Botafogo

**RESTRICTIONS TO THIS IL**

8. Continuous monitoring program of atmospheric emissions shall measure the gas output speed, temperature, pressure and flow, identifying them as O<sub>2</sub>, NO<sub>2</sub> and CO and shall be composed of automatic gauges, automatic filter cleaning system, gas sample conditioners, digital and analogical outlets for the gas burner control room, alarm system, data collection and storage. Data shall be sent, in real time, to FEEMA's CENTRAL DATABASE.
9. Continuous monitoring program of chimney shall contain 4 monitors. The other chimneys will be monitored according to schedule proposed on the Basic Environmental Plan.
10. Accomplishment of Air Quality Monitoring Program, as presented in the Basic Environmental Plan, monitoring pollutants NO<sub>x</sub>, NO, NO<sub>2</sub>, O<sub>3</sub>, HCT and CO continuously, besides the meteorological parameters, with installation of the Monitoring Unit which shall send the results, in real time, to FEEMA's CENTRAL DATABASE.
11. The acquisition, installation, operation and maintenance of the Treatment Plant is of entrepreneur's responsibility since the activation of Sewage Treatment Plant (UTE) until its total deactivation.
12. The Air Quality Monitoring Station shall begin sampling, at least, 90 days before the start of operations at UTE.
13. Implementation of the liquid effluents monitoring program, as established in the PBA, that shall be presented to FEEMA through Liquid Effluents Self-control Program - PROCON ÁGUA.
14. The treated liquid effluents shall be disposed at Macaé river, according to Technical Standard NT-202 R-10 from FEEMA.
15. Implementation of the groundwater and soil monitoring program, as established in the PBA, forwarding the results at the end of each scheduled campaign.
16. Implementation of controlling and monitoring procedures for erosive processes.

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Rio de Janeiro, April 06, 2001.

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President of FEEMA

*The construction, reform, extension, installation or operation of potentially polluting establishments, works or services, in violation to the applicable legal standards and regulations or non-compliance with legal or contractual obligation of relevant environmental interest may imply the crimes set forth in articles 60 and 68 of Act No. 9.605, of 02.12.98, and the violator, as an individual or a legal entity, shall be subject to the penalty of detention or payment of a fine.*

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## **RESTRICTIONS TO THIS IL**

17. Maintenance of a management plan of risks caused to the external population and internal staff, as a result of UTE's facilities, due to its existence, operation and/or use of hazardous substances. Sign, within thirty (30) days, commitment protocol with FEEMA's Risk Analysis Center, concerning the signatures of the UTE's personnel in charge, by the Risk Management Program; by the distribution of operation procedures and conditions; by the training and re-training; by the equipment and systems' guarantee, integrity and reliability and, by the development and implementation of the Emergency Action Plan.
  18. Accomplishment of the Hydrogeologic Survey Program, based on document prepared by the Mineral Resources Department of Rio de Janeiro - DRM-RJ, as presented in the PBA, containing resources of, at least, R\$ 180,000.00.
  19. Implementation of the Environmental Education Program, prepared as to the guidelines of Project – "Verde que te Quero Verde", developed by the State Department of Environment and Sustainable Development – SEMADS, and presented in the PBA, considering the integration of this program with the implementation of the Recomposition Program of the Ancillary Forest and Springs of Macaé river, and details of its accomplishment, are the objects of an agreement to be established between SEMADS and other participating entities, involving resources for the first ten-month term module, worth at least, R\$ 250,000.00.
  20. Implementation of the Recomposition Program of the Ancillary Forest and Springs of Macaé river - recovery of the Protection Limit Strip, according to the terms of agreement to be established between SEMADS and the other participating entities, involving resources of at least R\$ 1,600,000.00.
  21. Establishment of a creation project and development of a handling plan of the Environmental Protection Area - APA on the mouth of Macaé river, aiming to preserve mangrove areas, and the details of its accomplishment, are the object of an agreement to be established between SEMADS and other participating entities, involving resources of at least, R\$ 200,000.00.
  22. Implementation of a proposal for the recovery of the channel margins, located inside the growth of mangrove area on the mouth of Macaé river, and the details of its accomplishment, are the object of an agreement to be established between SEMADS and other participating entities, involving resources of at least, R\$ 1,500,000.00.
  23. Implementation of a proposal for the Study of Hydric Availability of Macaé River Basin, as presented in the PBA, and the details of its accomplishment, are the object of an agreement to be established between SEMADS and other participating entities, involving resources of at least, R\$ 270,000.00.
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Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

**FEEMA - Environmental Engineering State Foundation**

**INSTALLATION LICENSE**

**IL Nr. 125/2001**

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Company: EL PASO RIO CLARO LTDA.  
Located at Praia de Botafogo No. 440 – 14º andar – Botafogo

**RESTRICTIONS TO THIS IL**

24. Implementation of the Conservation Unit Supporting Program, in compliance with CONAMA Resolution N° 02/96 and Act N° 9985 of 07/18/00, with investments of resources stipulated in the legal provisions, depending on the definition of the Conservation Units to be favored and/or created by agreements established between SEMADS and the other participating entities, involving resources of at least, R\$ 4,000,000.00.
25. Presentation, within thirty (30) days, of a proposal for the accomplishment of the Aerial Emissions Inventory in the State of Rio de Janeiro, and the details of its accomplishment, are the object of an agreement to be established between SEMADS and other participating entities, involving resources of at least, R\$ 400,000.00.
26. Use of loan material for earth moving services, only from layers that hold environmental license issued by FEEMA.
27. Submittal to FEEMA, for analysis and opinion, of Risk Analysis, in case layout or pre-sizing of the Plant is modified, implying alterations to the risks established.
28. Dispose the exceeding loan material from earth moving in the enterprise area, complying with technical criteria of compaction and protection to erosive processes, provided that the height of the embankment does not exceed +10, and that area shall receive appropriate landscape treatment.

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Rio de Janeiro, April 06, 2001

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President of FEEMA

Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

**FEEMA - Environmental Engineering State Foundation**

**OPERATION LICENSE**

**OL Nr. 439/2001**

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As per Deliberation No. 003, of 12/28/77, by the State Committee for Environmental Control – CECA, the Environmental Engineering State Foundation – FEEMA, according to the powers granted to it by Decree-Law No. 134, of June 16, 1975, Article 8, and according to the Polluting Activity License System, established by Decree No. 1633, of December 21, 1977, hereby issues this Installation License, which authorizes

Company: EL PASO RIO CLARO LTDA.  
CNPJ/CPF: 02.290.787/0001-07  
Address: Praia de Botafogo No. 440 – 14º andar – Botafogo  
Adm. Reg/District Court: 6<sup>th</sup> RA – Botafogo  
Municipality of Rio de Janeiro, State of Rio de Janeiro, registered in FEEMA under code 10009420/35.11.10, to develop implementation studies regarding activity(ies) of natural gas Thermoelectric power plant. x-x-x-x-x-.

Located at: Highway BR-101, km 169 – Sítio Severina – Barra de Macaé, municipality of Macaé.

with the following restrictions:

1. Comply, within thirty (30) days, counting from the date of issuance of this License, with NA-052 – Regulation for Issuance of Obligatory Licenses and Environmental Impact Study for the Polluting Activity License System, approved by Deliberation CECA No. 2538, of 11/12/91 (Official Gazette of. 12/06/91) sending copy of issues to FEEMA, within the same term.
2. This License refers to environmental aspects and does not exempt the entrepreneur from complying with the other aspects required by law.
3. This License shall not be amended, in any way, nor plastic-coated, under penalty of losing its validity.

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This OL is effective until October 31, 2006, counting from the date hereof, as FEEMA Proceeding No. E-07/202.534/01, in compliance with the conditions set forth in this documents and its annexes, which although not transcribed herein shall be an integral part hereof.

Rio de Janeiro, October 31, 2001.

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ISAURA FRAGA  
President of FEEMA

*The construction, reform, extension, installation or operation of potentially polluting establishments, works or services, in violation to the applicable legal standards and regulations or non-compliance with legal or contractual obligation of relevant environmental interest may imply the crimes set forth in articles 60 and 68 of Act No. 9.605, of 02.12.98, and the violator, as an individual or a legal entity, shall be subject to the penalty of detention or payment of a fine.*

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## **RESTRICTIONS TO THIS OL**

4. Requirement of renewal of this Operation License with at least one-hundred and twenty (120) days before the end of its validity period, aiming to allow the use of prerogative of article 10, paragraph 4, of CONAMA Resolution N° 237/97.
  5. Implementation of the liquid effluents monitoring program, as established in the Basic Environmental Plan- PBA, that shall be presented to FEEMA through Liquid Effluents Self-control Program - PROCON ÁGUA, in compliance with DZ-942 R-07 - Guideline of the Liquid Effluents Self-control Program - PROCON ÁGUA, approved by CECA Deliberation n° 1007, of 10.10.90, published on the Official Gazette of Rio de Janeiro, of 01.14.91.
  6. Compliance with NT-202 R-10- Criteria and Standards for Liquid Effluents Disposal, approved by CECA Deliberation n° 1007, of 12.04.86, published on the Official Gazette of Rio de Janeiro, of 12.12.86.
  7. Accomplishment of water quality monitoring program proposed in the PBA, and revision of the same within six (06) months, based on the obtained results, specially on the biologic data.
  8. Presentation of water quality monitoring results in digital media, according to model provided by FEEMA, as stipulated in the PBA.
  9. Accomplishment of a continuous monitoring of atmospheric emissions in one (01) chimney of each group of four (04), measuring the gas output speed, temperature and flow, (identifying O<sub>2</sub>, NO<sub>2</sub> and CO). Data shall be sent, in real time, to FEEMA's Air Quality Central Database.
  10. Accomplishment of monitoring campaigns of emissions of the other three (03) chimneys of each group, according to schedule below, for the period of twenty-four (24) months, at the end of which there shall be a reevaluation of the monitoring periodicity:
    - 1<sup>st</sup> campaign: two (02) months after the beginning of each group's operation;
    - 2<sup>nd</sup> campaign: three (03) months after the first campaign;
    - 3<sup>rd</sup> campaign: six (06) months after the second campaign;
    - 4<sup>th</sup> campaign and the subsequent: every six (06) months.
  11. Continuous monitoring of air quality by means of an automatic station installed in the enterprise's external area, concerning the following parameters: NO<sub>x</sub>, NO, NO<sub>2</sub>, O<sub>3</sub>, HCT , CO, temperature, relative humidity, solar radiation, winds' direction and speed. Data shall be sent, in real time, to FEEMA's Air Quality Central Database.
  12. Accomplishment of a continuous measuring of wind direction and speed, on the enterprise area.
  13. Accomplishment of a reevaluation study of the localization of the air quality continuous monitoring station, after eighteen (18) months of operation.
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Government of the State of Rio de Janeiro  
State Department of Environment  
State Committee for Environmental Control

**FEEMA - Environmental Engineering State Foundation**

**OPERATION LICENSE**

**OL Nr. 439/2001**

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Company: EL PASO RIO CLARO LTDA.  
Located at Highway BR-101, km 169 – Sítio Severina, municipality of Macaé.

**RESTRICTIONS TO THIS OL**

14. Accomplishment of noise level monitoring campaigns, with presentation of biannual measurement reports containing:
  - Sound level measured in dB (A);
  - Noise length or, for variable levels, its statistic distribution;
  - Operational condition of noise source and prevailing climatic characteristics during measurements (wind temperature, direction and speed);
  - Noise occurrence hour and of measurements;
  - Corrected sound level;
  - Measured background noise level;
  - Noise criterion value with corrections for the period (daytime or nighttime) and zone (residential, industrial, etc);
  - Sketches with localization of measurement spots.
15. Performance of landscape and re-vegetation project using native species, according to the PBA, regarding:
  - Landscape treatment of inner and outer circulation areas of the enterprise
  - Implementation of vegetation ranges along the dividing fences
  - Formation of groves on the flat and hilly plots situated around the facilities
  - Ancillary vegetation enhancement that occurs in part of the limit strip of the old bed of the Macaé river, which limits the enterprise area to N- NE
16. Maintenance of a management plan of risks caused to the external population and internal staff, as a result of UTE's facilities, due to its existence, operation and/or use of hazardous substances, containing the signatures of the UTE's personnel in charge, by the Risk Management Program; by the distribution of operation procedures and conditions; by the training and recycling; by the equipment and systems' guarantee, integrity and reliability and, by the development and implementation of the Emergency Action Plan.
17. Implementation of the groundwater and soil monitoring program, as established in the PBA, forwarding the results at the end of each scheduled campaign.
18. Adoption of prevention measures for erosive processes on the enterprise area, pursuant to the PBA.
19. Presentation of follow-up reports of the signed agreements with the State Department of Environment and Sustainable Development – SEMADS to FEEMA, upon accomplishment of the respective schedules.
20. Previous submittal to FEEMA for analysis and opinion, any alteration to the activity incorporating them to the programs and plans presented. x-x-x-x-x-x-x-x-x-x

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Rio de Janeiro, October 31, 2001.

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President of FEEMA

<b>feema</b>	<b>GOVERNO DO ESTADO DO RIO DE JANEIRO</b> Secretaria de Meio Ambiente e Desenvolvimento Sustentável <b>FUNDAÇÃO ESTADUAL DE ENGENHARIA E MEIO</b>	PROCESS Nr. E-07/200.640/01	
		INITIALS clc	SHEET

# Notice

**Nr. 403.920**

Company: **EL PASO RIO CLARO LTDA**

CNPJ **02.290.787/0001-07**

COMPANY CODE: **10009420**

ACTIVITY CODE: **33.61.25**

ACTIVITY ADDRESS: **BR-101 Road**

DISTRICT/LOCALITY: **FAZENDA SEVERINA**

MUNICIPALITY: **Macaé**

CONTACT/REPRESENTATIVE: **Mr. Ricardo Salgado Martins, Phone: (21)538-4800**

**Pursuant to the disposal of the Environmental Control Legislation of Rio de Janeiro State, you are notified, that is authorized to begin the earthmoving works, according to the IL nr. 125/01. However, it's not authorized neither the installation of turbines nor plant's expansion.**

Rio de Janeiro, January 21, 2002

President of FEEMA

Employee # 3627430-6

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ISAURA FRAGA

First invoice received on 21/01/2002

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Nelson Bustamante  
Environmental Manager

## ATTENTION:

1. Refer to this document number on any correspondence sent to FEEMA about this subject
2. Any explanations about this document can be obtained at the following addresses.

<b>feema</b>	<b>GOVERNO DO ESTADO DO RIO DE JANEIRO</b> Secretaria de Meio Ambiente e Desenvolvimento Sustentável <b>FUNDAÇÃO ESTADUAL DE ENGENHARIA E MEIO</b>	PROCESS Nr. E-07/202.534/01	
		INITIALS dos	SHEET

# Notice

**Nr. 403.971**

Company: **EL PASO RIO CLARO LTDA**

CNPJ **02.290.787/0001-07**

COMPANY CODE: **10009420**

ACTIVITY CODE: **33.61.25**

ACTIVITY ADDRESS: **BR-101 Road**

DISTRICT/LOCALITY: **FAZENDA SEVERINA**

MUNICIPALITY: **Macaé**

CONTACT/REPRESENTATIVE: **Mr. Ricardo Salgado Martins, Phone: (21)538-4800**

**Pursuant to the disposal of the Environmental Control Legislation of Rio de Janeiro State, according to Decree No. 1.6377/77, you are notified by this document that the modifications on the original design of Macaé Merchant TPP, owned by EL PASO RIO CLARO LTDA, was approved, in order to allow increasing the plant power and, therefore, authorizing the development of the associated works, according to process E-07/202534/01**

Rio de Janeiro, February 14, 2002

President of FEEMA

Employee # 3627430-6

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ISAURA FRAGA

First invoice received on 14/02/2002

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Nelson Bustamante  
Environmental Manager

## ATTENTION:

1. Refer to this document number on any correspondence sent to FEEMA about this subject
2. Any explanations about this document can be obtained at the following addresses.

<b>feema</b>	<b>GOVERNO DO ESTADO DO RIO DE JANEIRO</b> Secretaria de Meio Ambiente e Desenvolvimento Sustentável FUNDAÇÃO ESTADUAL DE ENGENHARIA E MEIO	PROCESS Nr. F-07/202 534/01	
		INITIALS dos	SHEET

# Notice

**Nr. 403.972**

Company: **EL PASO RIO CLARO LTDA**

CNPJ **02.290.787/0001-07**

COMPANY CODE: **10009420**

ACTIVITY CODE: **33.61.25**

ACTIVITY ADDRESS: **BR-101 Road**

DISTRICT/LOCALITY: **FAZENDA SEVERINA**

MUNICIPALITY: **Macaé**

CONTACT/REPRESENTATIVE: **Mr. Ricardo Salgado Martins, Phone: (21)538-4800**

**Pursuant to the disposal of the Environmental Control legislation of Rio de Janeiro State, according to Decree No. 1.6377/77, you are notified by this document that when implementing the modifications to the original design of Macaé Merchant TPP, owned by EL PASO RIO CLARO LTDA, the attached restrictions must be met, according to process E-07/202534/01**

Rio de Janeiro, February 14, 2002

President of FEEMA

Employee # 3627430-6

\_\_\_\_\_  
ISAURA FRAGA

First invoice received on 14/02/2002

\_\_\_\_\_  
Nelson Bustamante  
Environmental Manager

## ATTENTION:

1. Refer to this document number on any correspondence sent to FEEMA about this subject
2. Any explanations about this document can be obtained at the following addresses.

# Annex to Notice

Nr. 403972

## Restrictions:

1. To operate and maintain a continuous air emission monitoring system addressed to the four new turbine-generator units, for the following parameters: flue gases speed, temperature, pressure and flow rate as O<sub>2</sub>, NO<sub>x</sub> and CO, forwarding these data to the Air Quality Data Center of FEEMA, on a real-time basis;
2. To monitor all four new turbine generator units, to which the installation of four sensors and two monitors are allowed, i.e., one monitor to each pair of sensors, one at each stack, providing alternate data every 15 minutes, so all stacks are continuously monitored;
3. Install an automatic air quality monitoring station in an area to be defined by FEEMA, within 120 days, addressed to the following parameters: NO<sub>x</sub>, NO, NO<sub>2</sub>, O<sub>3</sub>, Total Hydrocarbons, CO, temperature, relative humidity, solar radiation, direction and speed of the winds, forwarding these data to the Air Quality Data Center of FEEMA, on a real-time basis.

Isaura Fraga  
President of FEEMA