MACAÉ MERCHANT TPP

Basic Environmental Programs

Request of Installation License

Volume 1

elpaso Energy International

ECOLOGUS
Engenharia Consultiva

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1 PRESENTATION

This document comprises the Basic Environmental Program (PBA) of Macaé Merchant Thermal Power Plant (TPP) corresponding to the detailing of the environmental programs at both the Environmental Impact Assessment and the Environmental Impact Reports (EIA/RIMA) of the plant (700 MW), as well as to the detailed engineering programs.

The Basic Environmental Program (PBA) presented here aims at complying with the requirements at the Previous License LP Nº 013/2001 addressed to the aforementioned plant, granted by FEEMA in 03/13/2001, while meeting to the existing legislation and starting the process addressed to granting the Installation License of Macaé Merchant TPP, a responsibility of EL PASO RIO CLARO LTDA, comprising the installation of the following facilities: thermal power plant, associated infrastructure; interconnection to the transmission line (FURNAS, 345 kV) and accesses.

It must be highlighted that the pipeline branch to be used for distributing natural gas, a responsibility of the Companhia Distribuidora de Gás do Rio de Janeiro – CEG, will be addressed in a specific Installation License, followed by the issue of a Technical Report including the detailing of the environmental programs related to its construction and operation. Therefore, the requests of the aforementioned Previous License regarding the distribution pipeline (items 5.9 and 5.13) will me answered by CEG in a specific report.

The development of this document took in account the comments and requests arisen from the Public Audience performed on 02/15/2001 in the municipality of Macaé.

This PBA was performed in accordance with the guidelines of the valid environmental legislation, according to Resolution CONAMA 06/87, as well as in compliance with the supplementary requests of the Previous License Nº 013/2001, issued on 03/13/2001.

The environmental licensing process of Macaé Merchant TPP has started on 09/20/00 when the Previous License Request was recorded at FEEMA, originating the Process FEEMA E-07/201.895/00 dated of 10/03/00. The specific permit-documents and requests addressed to the project implementation are listed next:

- The right for water utilization was technically approved by the Water Resources Directory of SERLA (process E-07/101.373/00 dated of 10-25-00), and the Granting Decree by the State Government is being expected (See Annex at the end of this Section);
- authorization for constructing an access to the site the National Roads Department–DNER ;
- negotiation process with FURNAS Centrais Elétricas S.A. addressed to the physical interconnection; with the National Operator of the National Electric

System - ONS and with ANEEL regarding the utilization of the transmission system;
- 12/15/2000: ANEEL (Resolution 551), authorized EL PASO RIO CLARO LTDA. as an independent power producer by implementing Macaé Merchant TPP e and its respective transmission system (Annex);
- 12/19/00: El Paso forwarded to FEEMA specific documentation requesting the Installation License of the earthworks within the site area, according to annexed copy.

The structure of the Basic Environmental Project (PBA) was developed in order to allow the understanding of both the project and the area where it is going to be located, so all proposed environmental measures and programs addressed to the mitigation of the impacts identified by the EIA/RIMA can be understood, as well as the requests established at the Previous License, aiming at granting the Installation License of the project.

The document comprise two volumes composed as follows -

Volume 1 – Descriptions of the projects that compose the PBA in 8 Chapters:

- Chapter 1 - Presentation;
- Chapter 2 – Entrepreneur;
- Chapter 3 – Project Characterization;
- Chapter 4 – Basic Description of Equipment and Systems;
- Chapter 5 – Detailed Projects of Macaé Merchant TPP;
- Chapter 6 – Environmental Management System of the Project;
- Chapter 7 – Conclusion;
- Chapter 8 – Technical Team.

Volume 2 – Annexes – Engineering Drawings, following the presentation sequence of the project item to which they are related:

Annex I – Project Characterization (Chapter 3)
- General Layout of the Plant (Drwg. ARG-010)

Annex II – Basic Description of Equipment and Systems (Chapter 4)
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The engineering projects are a responsibility of EL PASO RIO CLARO Ltda. The environmental programs presented in this volume were developed by the technical team of ECOLOGUS ENGENHARIA CONSULTIVA LTDA. from Rio de Janeiro, registered at the federal technical Register of Activities and Instruments of Environmental defense, held by IBAMA.

The restrictions of the Previous License No. 013/2001 were met and the respective elucidations are presented in the next Table.

Table 1.1 – Items Related to the Restrictions of the Previous License Nº. 013/2001

RESTRICTION OF THE PREVIOUS LICENSE No. 013/2001	DESCRIPTION OF THE DETAILED PROJECTS	CHAPTER – ITEM
5.1.	Buildings and Lay out	Chap. 5 - Item 5.1
5.2.	stormwater Drainage System	Chap. 5 – Item 5.2
5.3.	Sewerage System	Chap. 5 – Item 5.3
5.4.	Water Supply System	Chap. 5 – Items 5.4
5.5.	Water Intake at Macaé River	Chap. 5 – Item 5.5
5.6.	Infrastructure and Construction Site	Chap. 5 – Item 5.6
5.7.	Liquid Effluents Treatment	Chap. 5 – Item 5.7
5.8.	Landscaping	Chap. 5 – Item 5.8
5.9	Natural Gas Distribution Pipeline	Not apply to the scope of this PBA
5.10.	Transmission Line	Chap. 5 – Item 5.10
5.11.	Detailed Project of Earthworks	Chap. 5 – Item 5.11 Already presented to FEEMA, resulting on the Earthwork License – LI - nº 089/2001, issued on 03/193/2001
5.12.	Acoustic Insulation of the Turbines	Chap. 5 – Item 5.12
5.13.	Archaeological Survey	Chap. 5 – Item 5.13
5.14.	Temporary Sludge Disposal	Chap. 5 – Item 5.14
5.15.	Recomposition of the Marginal protection Border	Chap. 6 – Item 6.1.2 / 6.3.1
5.16.	Handling Plan– Studies for the Conservation Unit of Macaé river Mangrove areas	Chap.6 – Item 6.3.2

Table 1.1 – Items Related to the Restrictions to the Previous License Nº. 013/2001

RESTRICTION OF THE PREVIOUS LICENSE No. 013/2001	DESCRIPTION OF THE DETAILED PROJECTS	CHAPTER – ITEM
5.17.	Recovery of Macaé-Campos Channel	Cap 6. – Item 6.3.3
5.18.	Monitoring of the Water Quality of Macaé river	Chap. 6 – Item 6.2.4
5.19.	Monitoring of Air Quality and Meteorological Parameters	Chap. 6 – Item 6.2.3
5.20.	Continuous Monitoring of Air Emissions	Chap. 6 – Item 6.2.2
5.21.	Noise Level Monitoring	Chap. 6 – Item 6.2.1
5.22.	Monitoring of Soils and Groundwater	Chap. 6 – Item 6.2.6
5.23.	Monitoring of Solid Wastes	Chap. 6 – Item 6.2.8
5.24.	Monitoring of Soils and Erosions Processes	Chap. 6 – Item 6.2.7
5.25.	Risks Management Program	Chap. 6 – Item 6.1.3.
5.26.	Study on the Hydric Availability of Macaé river Basin	Chap. 6 – Item 6.3.4.
5.27.	Survey on Groundwater	Chap. 6 – Item 6.3.5.
5.28.	Social Communication and Environmental Education Programs	Chap. 6 – Items 6.1.4 e 6.3.6
5.29.	Program of Support to Conservation Units	Chap. 6 – Item 6.3.7
5.30.	Environmental Offsetting of the National Park of Jurubatiba Coastal Forest	Chap. 7 – Item 6.3.8
Recommendations of the EIA	Manpower Contracting and Demobilization Program	Chap. 6 – Item 6.1.5
Recommendations of the EIA	Environmental Construction Program - PAC	Chap. 6 – Item 6.1.1
Recommendations of the EIA	Effluents Quality	Chap. 6 – Item 6.2.5

2 CHARACTERIZATION OF THE ENTREPRENEUR

EL PASO RIO CLARO LTDA, which is part of EL PASO ENERGY INTERNATIONAL, is the company responsible for the design and implementation of Macaé Merchant Thermal Power Plant, located in the municipality of Macaé, Rio de Janeiro state.

EL PASO ENERGY INTERNATIONAL is a worldwide leading company in power infrastructure projects, offering management services on design, materials, operation and construction areas comprising all steps of the project, from the conceptual design to the construction, operation and maintenance steps. The multiple experience on a variety of power generation methods has been making of EL PASO ENERGY INTERNATIONAL one of the largest international investors in the natural gas industry, participating on 28 energetic projects located in all five continents, including 7.252km of gas pipelines and over 7.000MW of generated power.

EL PASO ENERGY INTERNATIONAL has successfully developed projects in Argentina, Australia, Chile, China, Czech Republic, Hungary, Indonesia, Korea, Mexico, Pakistan, Peru and USA. As for power figures, EL PASO ENERGY INTERNATIONAL has presently reached the remarkable value of 7.025MW from operating plants, 1.746MW under construction and 11.000MW under design, associated to 7.252km of gas pipelines implemented as follows:

Americas: generation of 4.945MW and 3.960km of gas pipelines and reserves reaching 95MMBbl of oil and 1.037Bcf of natural gas/gas treatment facilities;

Europe: generation of 944MW;

Australia: 3.252km of gas pipelines;

Asia: generation of 1.154MW, 40km of gas pipelines and 533 Bcf of natural gas reserves.

Established in 1928, EL PASO ENERGY CORPORATION is a fully integrated power company, participating on all segments of the energetic chain. EL PASO CORPORATION is responsible for over 40,000 miles of operating distribution gas pipelines throughout North America.

Counting on over US$ 16 billions in assets, EL PASO ENERGY CORPORATION provides solutions for power problems by means of its strategic business units, such as Tennessee Gas Pipeline Co., El Paso Natural Gas Co., Southern Natural Gas Co., El Paso Merchant Energy Co., El Paso Energy International Co., El Paso Field Services Co., and El Paso

Production Co. In Janeiro, 2000, EL PASO ENERGY announced a merging agreement with The Coastal Corp.

The data on the company responsible for the project are:

Name:	El Paso Rio Claro Ltda.
Address:	Praia de Botafogo, 440/14^{o} Andar – Botafogo – Rio de Janeiro – RJ
CEP:	22.250-040
Phone number:	(0xx-21) 538-4800
E-mail:	almeidar@epenergy.com
CNPJ:	02.290.787/0001-07
Responsible:	Roberto Almeida

3 PROJECT DESCRIPTION

3.1 LOCATION

Macaé Merchant Thermal Power Plant is located close to km 164 of BR 101 road, in the locality of Severina, municipality of Macaé, in a land owned by El Paso Rio Claro Ltda.

Figure 3.1 next depicts an aerial picture of the site, whose limits are represented by blue lines, comprising a total area of about 100 ha. The general layout of the future facilities is described next.

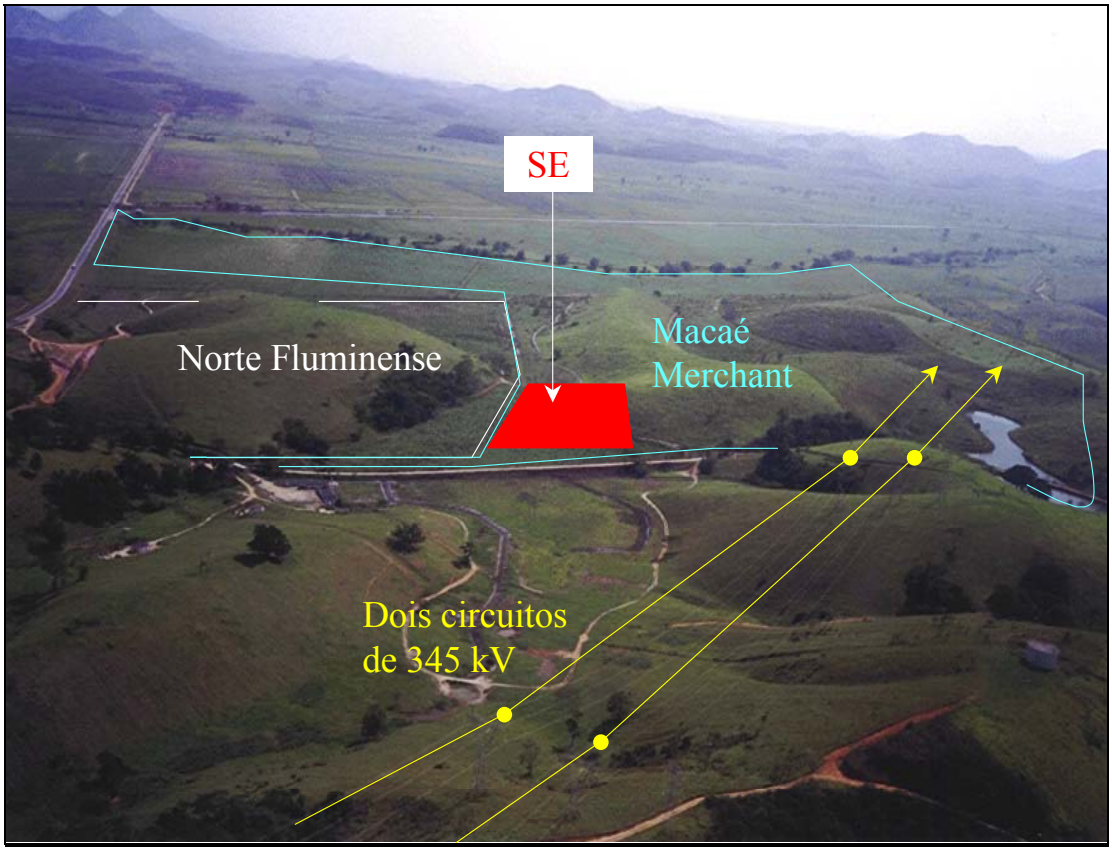


Figure 3.1 – Implementation Area if Macaé Merchant TPP.

3.2 GENERAL LAYOUT

As can be observed in Figure 3.1, the site at the left portion of the picture, delimited by white lines, corresponds to the area destined to the future site of Norte Fluminense TPP, while the area delimited by blue lines, at the right portion of the picture, displays the hill where Macaé Merchant TPP will be constructed. The red area indicated the location of the future substation,

which will serve EL Paso and which is expected to be expanded in the future in order to accommodate the needs of Norte Fluminense TPP. A line of trees in the upper part of the picture indicates the old bed of Macaé river, while the trained Macaé river can be observed behind this area. BR 101 road can be observed at the far-left border of the site.

The route of the gas pipeline that will supply the plant is schematically represented by a pink line. The gas pipelines will reach a spot close to BR-101 road, where a metering/gas reduction station will be installed (white square). This station, also called City Gate, will be installed in this area in order to allow the gas concessionaire (CEG RJ) to perform the required measurements without accessing Macaé Merchant TPP area. From the City Gate, a 1-km long branch will route the gas to the site.

This layout of the gas pipelines is also adequate to the needs of the future Norte Fluminense TPP, whose City Gate can be installed close to Macaé Merchant one, providing the same benefits to CEG regarding future measurements without accessing the site.

The 345 kV transmission line of Furnas crosses Macaé Merchant Site, exempting the design from the need for constructing a new interconnection transmission line.

The access to the plant will be performed from BR-101, as indicated by the orange line. The procedures addressed to request the authorization for implementing this access has been already forwarded to DNER and no difficulties are expected regarding the grant of the licenses before that agency, since the visibility conditions in the area are very adequate.

Volume 2, Annex I presents the general layout of the plant facilities (Des. ARG-010), indicating the location of the GTG's, chillers, water treatment plant, administration building, i.e., all main components of the TPP and also the existing transmission lines of Furnas that cross Macaé Merchant site (2 of 345 kV and 1 of 138 kV).

3.3 PRODUCTION REGIMEN

Macaé Merchant is a thermal power plant specially designed and constructed for operating in accordance with the Electric Energy Wholesale Market (MAE). Therefore, the plant operation will depend on the power prices practiced by MAE; if these prices lie within a minimum range of values, which justifies the plant operation, the plant will run 2 or more turbines, up to a maximum number of 16 units (according to the demand predicted by MAE).

However, the specifications generated by El Paso for the TPP take in account the plant operation under a base-load regimen, i.e., able to operate under full load 24 hours a day. It is expected that during the first operation years of the TPP, the production regimen is a base one, according to the needs of the Brazilian Electric System. The project criteria considers the redundancy of instrumentation, control and protection systems and stand-by equipment, in order to achieve an optimum reliability level as required for the interconnection to the integrated 345kV transmission system.

The change on the plant load can be achieved by shutting down one or more turbines or by reducing the load of the turbines up to 90%, since the operation of the GTG's at low loads takes to a significant reduction on the turbine efficiency. The start up of a turbine, in the case of Macaé Merchant TPP, can last 20 minutes from a cold condition or at a 180 kW/s ramp-up, in case of an operating turbine.

3.4 GENERAL CHARACTERISTICS OF THE PLANT

Macaé Merchant TPP will be a single-cycle plant with a maximum rated capacity of 700MW, composed by 16 GTG's comprising gas turbines with unit power of 43MW designed for firing natural gas, each of them coupled to a air-cooled generator. Combined cycle plants differ from single cycle ones by making use of the exhausting gases from the turbine for generating steam, which subsequently expands in a steam turbine, generating additional power. Consequently, the open cycle plants present a lower overall efficiency when compared to combines cycle units. However, single cycle plants present characteristics which are desirable for a Merchant plant, such as fast start up, shorter implementation and the ability to generate power within different levels, depending on the number of operating turbines.

The terminals of the 16 generators will be interconnected to 8 main step-up transformers, one for each pair of generators. Macaé Merchant TPP will be interconnected to the Southeast-South-Middle West Interconnected System through the 345kV line of FURNAS, by means of a substation to be implemented in the area.

The selected turbines are LM 6000 types, further described in Chapter 4 of this report. These turbines are the best-efficiency equipment for the considered power range (40 to 70 MW), so regardless the energy wasted with the exhausting gases, the selected equipment corresponds to the lowest losses among the available commercial turbines. The recent improvements on

combustion turbines' technologies has increased the efficiency of these equipment to a range of values between 30% to 35%.

Considering the strong sensitiveness of gas turbines to changes on the room temperature (the efficiency drops significantly as the temperature increases), the plant design considered cooling down the turbine air intake by using chillers. Considering the available commercial equipment, the project design selected a model able to operate in an arrangement of 3 chillers for each set of 4 turbines, so 12 chillers will serve the whole plant, or 16 turbines. These chillers are also better described in Chapter 4.

The main consumption products of the plant are:

- Natural gas (fuel for the turbines); and
- Water, to be collected in Macaé river.

The gas will be supplied by CEG Rio by means of a gas pipelines that will interconnect two gas pipelines of Petrobras, Gasduc I and Gasduc II (which, in turn, interconnect the Natural Gas Processing Unit of Cabiúnas to Duque de Caxias Refinery – REDUC) up to a pressure reduction/metering station located within Macaé Merchant site. The gas pipeline is the scope of a specific project to be submitted to FEEMA by CEG Rio.

The water intake will be performed in an area adjacent to Macaé Merchant site, located across BR-101 road (See Volume 2, Annex VI – Water Intake– Location Plan). This option is exclusively related to the easiness on acquiring lands in the targeted region. The water intake pipelines will cross BR-101, according to the description presented in Item 5.4. The collected water will be treated and basically used in the cooling provokes and for NOx abatement purposes (which is performed by injecting water into the combustion chamber of the turbine). Details of this system are presented in item 5.4.

The liquid effluents produced by the Plant will be properly treated before their disposal into Macaé river. The sanitary sewer will also undergo a proper treatment before its final disposal. These systems are further described in items 5.3 and 5.7 respectively.

The air emissions of the plant will lie below the maximum allowed limits, according to the legislation. Since the fuel to be used is practically free of sulfur, the H2S emissions will be neglectable. The NOx emission levels will be controlled by injecting demineralized water into the turbine. The detailed description of the emission abatement and control systems is presented in item 6.2.2 as part of the Environmental Monitoring Programs.

The solid wastes generated by the plant will come from the sewerage and water treatment systems. Both types of wastes will be sent to disposal facilities, properly licensed by FEEMA to receive this type of material. Item 5.14.1 presents a detailed description of these systems.

Regarding noise emissions, a detailed study on noise generation and abatement and assessment of the effects of noise levels at the borders of the site are detailed in the specific project of acoustic insulation of the turbines, presented in item 6.2.1 of this document.

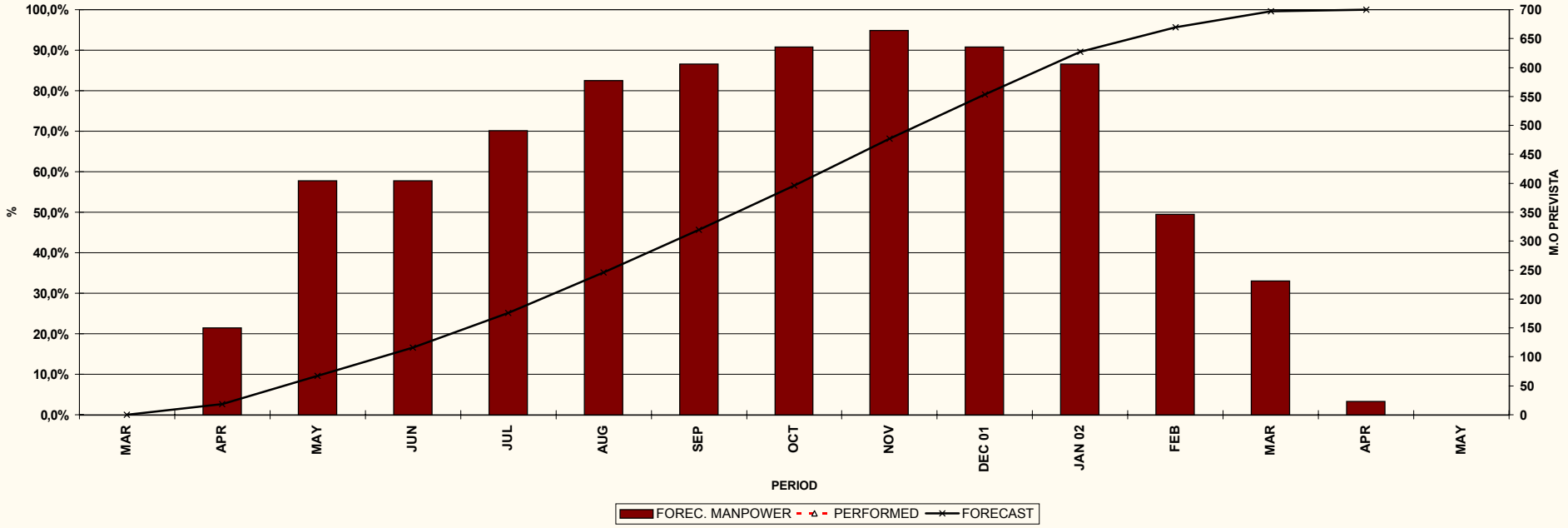
3.5 MANPOWER AND TIMETABLE

The manpower expected to be used during the construction and assemblage steps of Macaé Merchant TPP and the associated timetable are presented next. A total number of 650 workers is expected to be allocated during the peak period of the implementation works.

Manpower timetable

(see const_mp.pdf)

EL PASO ENERGY
UTE MACAE MERCHANT
MANPOWER UTILIZATION -
CONSTRUCTION AND ASSEMBLAGE



	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC 01	JAN 02	FEB	MAR	APR	MAY
FORECAST	0,0%	2,6%	9,6%	16,6%	25,1%	35,1%	45,6%	56,6%	68,1%	79,1%	89,6%	95,6%	99,6%	100,0%	
PERFORMED															
FOREC. MANPOWER		150	404	404	491	578	606	635	664	635	606	347	231	23	0
MAN HOURS		45495	122488	122488	148735	174983	183732	192481	201230	192481	183732	104990	69993	6999	

Project timetable

(see implementation Timetable.pdf)

MACAÉ MERCHANT TPP – IMPLEMENTATION TIMETABLE

DESCRIPTION	MONTHS										
	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
CONSTRUCTION											
Site preparation											
Construction of GTGs Bases											
Construction of the remainder structures											
Assemblage of the GTGs											
Installation of the Water Treatment and Water Intake											
Construction of the Control Building											
Installation of the Substation and Transformers											
COMMISSIONING AND START UP											
Start Up of thew Water System											
Electrical Interconnection - 345 kV											
Start up of the GTGs (*)											

(*) Sequential start-up: 1st set of 4 units in the 8th months, 2nd set in the 9th months, 3rd set in the 10th months and 4th set in the 11th month of the timetable.

4 BASIC DESCRIPTION OF EQUIPMENT AND SYSTEMS

4.1 TURBINE GENERATORS GROUPS AND AUXILIARY EQUIPMENT

4.1.1 OPERATIONAL AND DESIGN CHARACTERISTICS

Macaé Merchant TPP is able to operate under base load and cyclic conditions, with a warranted availability facto of 90%. The design considers redundancy criteria by instrumentation and control systems and stand-by equipment and protection in order to reach the desired optimum reliability level regarding the interconnection to the integrated transmission system (345kV).

During normal operation, the load can be changed by operating one or more gas turbines in partial load conditions and/or by running or stopping operation units. Considering that low load GTG's imply an appreciable reduction on the efficiency, the low-load operation of the plant is not economically recommendable. The main equipment and systems of Macaé Merchant TPP are presented next.

4.1.2 TURBINE-GENERATOR GROUP

The turbines will be LM 6000PC-NGW types, manufactured by General Electric, comprising a two-axis turbine derived from CF6-80C2, the turbine used at Boeing 747, among other wide body airplanes. The reliability of this turbine exceeds 99,88%. Both turbines (LM 6000 and CF6-80C2) present several identical components such as the low-pressure turbine, the high-pressure air compressor and the combustors, indicating the high reliability of the equipment.

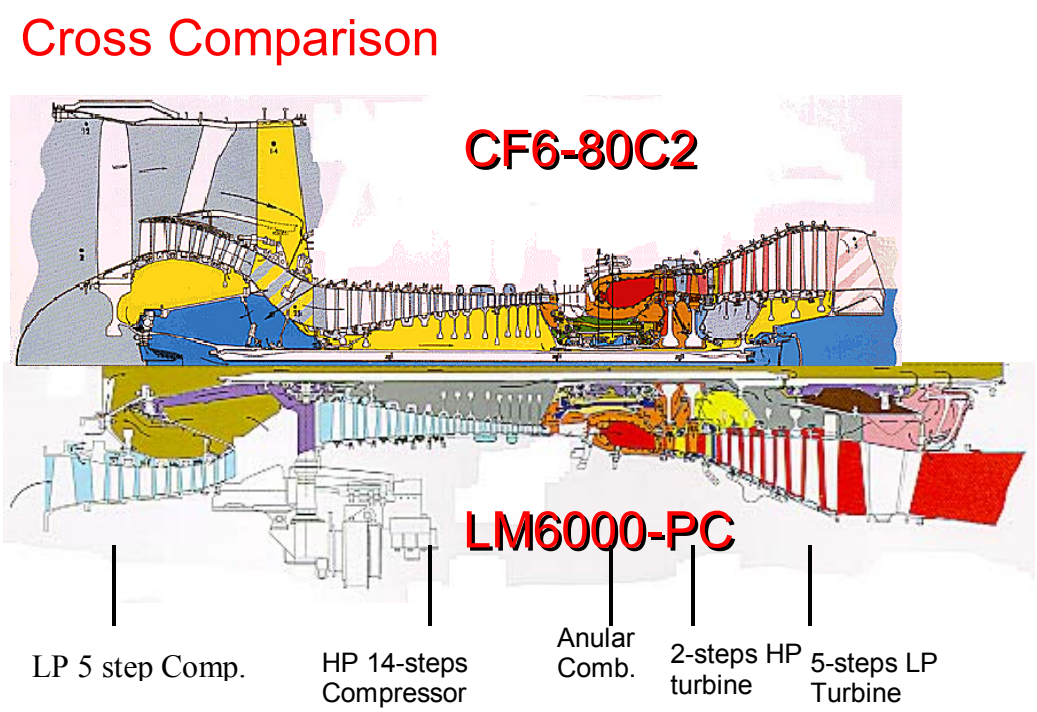
The main components are:

- Low pressure, 5-steps compressor
- High pressure, 14-steps compressor
- Annular combustor
- 2-steps power turbine
- Low pressure, 5-steps turbine

↳ Gear Box

These components are schematically depicted at Figure 4.1-1 next.

Figure 4.1-1 – Comparison between Existing Components - Turbines



LM6000-PC and CR6-80C2

The turbine cycle is depicted at Figure 4.1-2, next.

These units will operate under single cycle, firing natural gas and using water injection for NOx abatement purposes. The NOx control will be performed within the combustion section of the turbine, by injecting demi water (see item 5.4). The water will provide the reduction of the adiabatic flame temperature, minimizing the production of NOx.

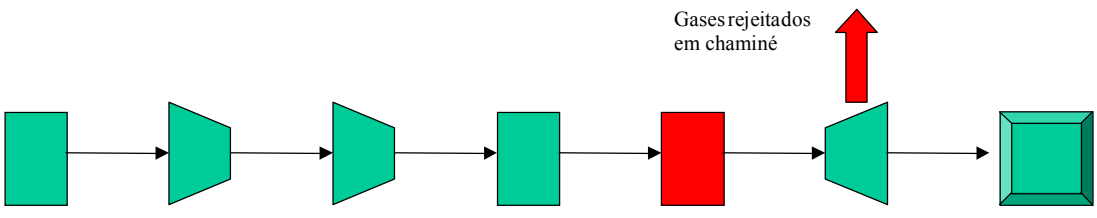


Figure 4.1-2 –Turbine Cycle

Legenda para a Figura acima

Gases rejeitados em chaminé = Flue gases
Filtro de ar = Air filter
Compressor de ar de baixa pressão (Razão de compressão 2.4:1) = Low pressure air compressor (Compression ration 2.4:1)
Compressor de ar de alta pressão (Razão de compressão 12:1) = High pressure air compressor (Compression ration 12:1)
Mistura de ar com gás nos bicos injetores = Air-gas mixture in the injection nozzles
Expansão dos gases através da turbina de alta pressão e da turbina de baixa pressão = Gases expansion through the high and low pressure turbines
Gerador = Generator

Each turbine is provided with an axial outlet exhauster in order to make easy the on-line assemblage of the outlet stack. Noise abatement silencers are provided within the exhaustion duct in order to reduce the noise emissions to adjacent areas. The stack is high enough to provide dispersion conditions enough for meeting Brazilian environmental requirements.

The turbine performance data are presented in the next Table:

Table 4.1-1 – Characteristics of the LM 6000PC-NGW Turbine

Rook temperature	ºC	5	10	15	20	25	28	30	35	40
Compressor inlet temperature	ºC	5	10	10	10	10	10	12	17	22
Relative humidity	%	86	86	86	86	86	86	86	86	86
Elevation	m	20	20	20	20	20	20	20	20	20
NG		GN	GN	GN	GN	GN	GN	GN	GN	GN
Low Heating Value	kJ/kg	48391	48391	48391	48391	48391	48391	48391	48391	48391
Inlet Head Loss	mmH2O	130	130	130	130	130	130	130	130	130
Outlet Head Loss	mmH2O	150	150	150	150	150	150	150	150	150
Axis power	kW	48484	46244	46244	46244	46244	46244	45107	42191	39149
Generator efficiency	%	97.7	97.6	97.6	97.6	97.6	97.6	97.7	97.7	97.7
Generator power	kW	47369	45134	45134	45134	45134	45134	44070	41220	38248
NOx	ppm	60	60	60	60	60	60	60	60	60
“Heat Rate” considering the power at the generator terminals	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
Exhaustion flow rate	kg/s	132.1	128.8	128.8	128.8	128.8	128.8	127.2	123.0	118.3

Exhaustion temperature	ºC	448.3	448.3	448.3	448.3	448.3	448.3	447.9	447.6	448.6

The turbine will be directly coupled to the generator by means of a metallic flexible coupling. The air-cooled generator will operate at 3600rpm, 13,8kV, 60Hz and it will be able to maintain the full continuous power of the gas turbine within the design temperature range. A brush-free exciter with a permanent magnet will be used. The voltage regulation, synchronization and power factor will be controlled by the Turbine Control Panel. The generator bearings will be protected by a loop-operating, oil-lubricated system, externally assembled and water-cooled. Each generator will be connected to the step-up transformer by means of a bar, connected to the bar-ring of the yard.

Both the turbine and the generator will be enveloped by impermeable acoustic casing. The turbine compartment will be fully ventilated by means of redundant fans, while the generator compartment will be ventilated by a fan mounted on the generator axis. Both compartments will be provided with an explosion-proof lighting system and protected by an automatic fire-fighting system (CO_2). In addition to this, both the turbine and generator casings will assure a noise level below to 85 dB (A) at 1 m from the equipment.

Abnormal concentrations of natural gas within the casings will be detected by three gas sensors (2 for the turbine and 1 for the generator). An alarm is activated when the gas concentration exceeds 20% LEL and an automatic shutdown is triggered when the gas concentration reaches 60% LEL. Four flame detectors (3 for the turbine and 1 for the generator) also trigger an automatic shutdown, releasing CO_2 when one or more of them are activated. In addition to this, high temperature alarms within the casings also monitor not only the room temperature but also the temperature increase rate. Other four temperature sensors trigger the shutdown process when the internal temperature of the turbine casing reaches 232 C (2 sensors) or when the temperature within the generator sensor reaches 107 C (2 sensors). The CO_2 is composed by two main bottles, stand-by bottles, pipes and fittings. If the fire is not depleted within the first 90 minutes, the stand-by bottles are activated. The CO_2 system is designed so the gas concentration within the casing prevents any flame within 30 seconds.

The pictures presented next display a GE LM 6000 turbine and the entire GTG existing in a TPP in Manaus, owned by El Paso.

Figure 4.1-3 –GE LM 6000 Turbine

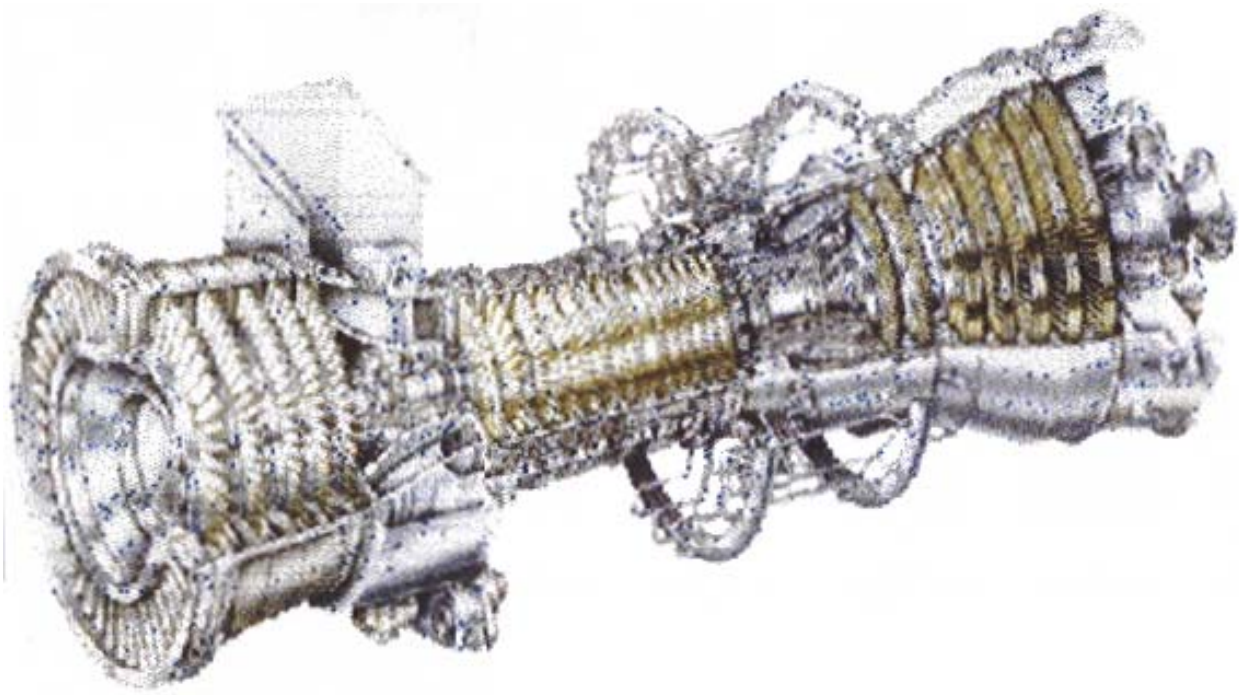


Figure 4.1-4 – Similar GTG implemented at Manaus Plant

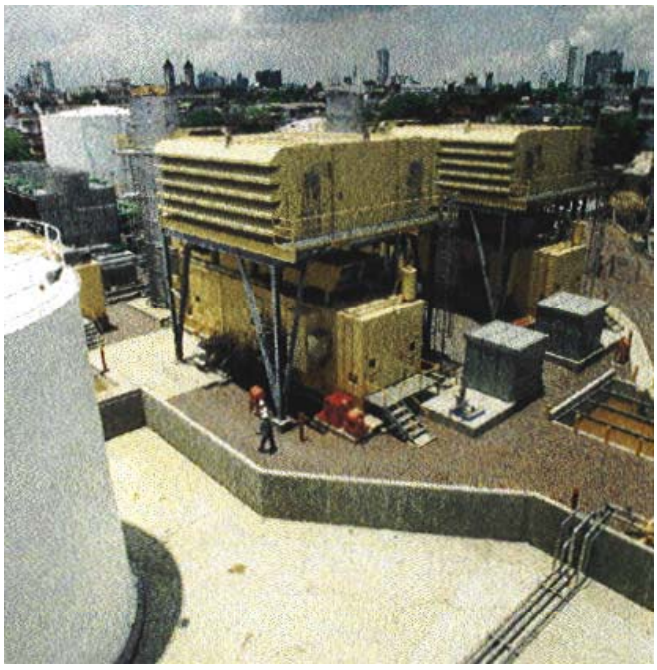


Figure 4.1-5 – TPP similar to Macaé Merchant, with 4 LM 6000 GTG's, working in the USA.

4.1.3 AUXILIARY SYSTEMS OF THE GTG'S

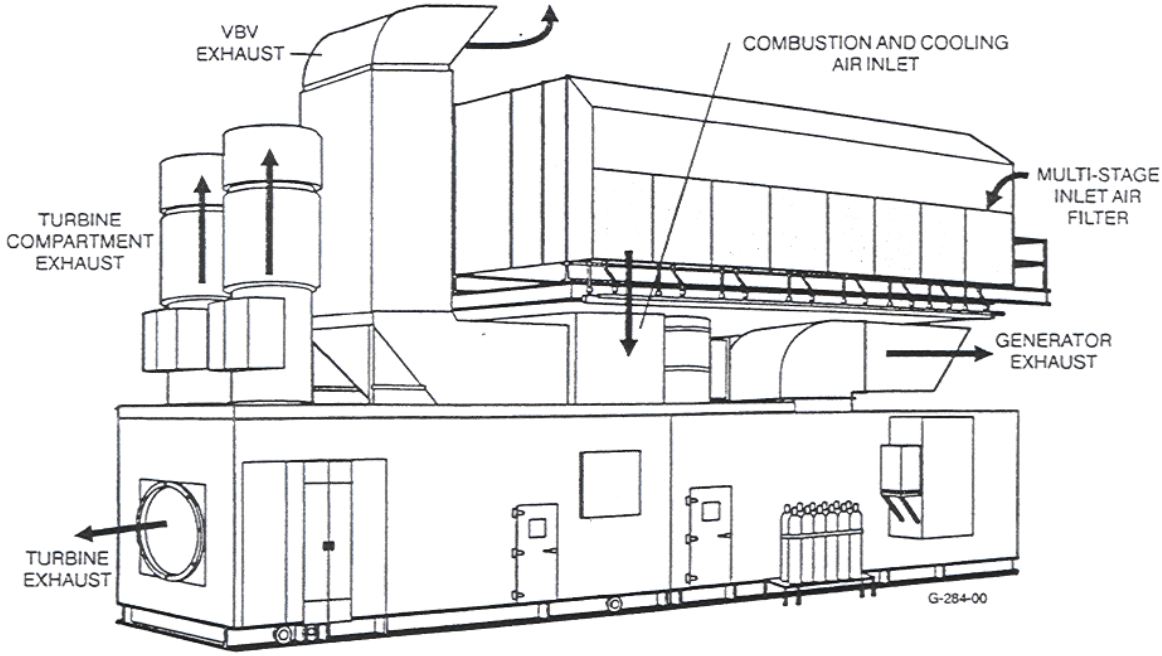
The auxiliary systems comprise the fuel system, air intake system, lube oil system, inlet air cooling and water injection for NOx abatement. These systems are described next:

Fuel System: The pressure of the natural gas delivered at the plant, after the pressure metering and reduction station (City Gate), must reach 56 bar(g). Therefore, no further compression will be required within the plant. The pressure required for the turbine is 46 bar (g), so a pressure control valve will ensure that the gas is supplied to the turbine at a constant pressure for all load ranges. The gas temperature will be controlled and warming system might be provided in order to ensure the absence of condensate at the turbine inlet;

Lube Oil System: composes by two independent oil systems, one for the gas turbine and one for the generator. The oil reservoirs and pipelines will be made in stainless steel and the supports of the lube oil valves will be also made in stainless steel. Each lube oil system will be provided with a duplex filter and duplex coolers. The coolers, the lube oil reservoir of the gas turbine and the filters of each system will be mounted in the auxiliary equipment module, close to the base of the gas turbine;

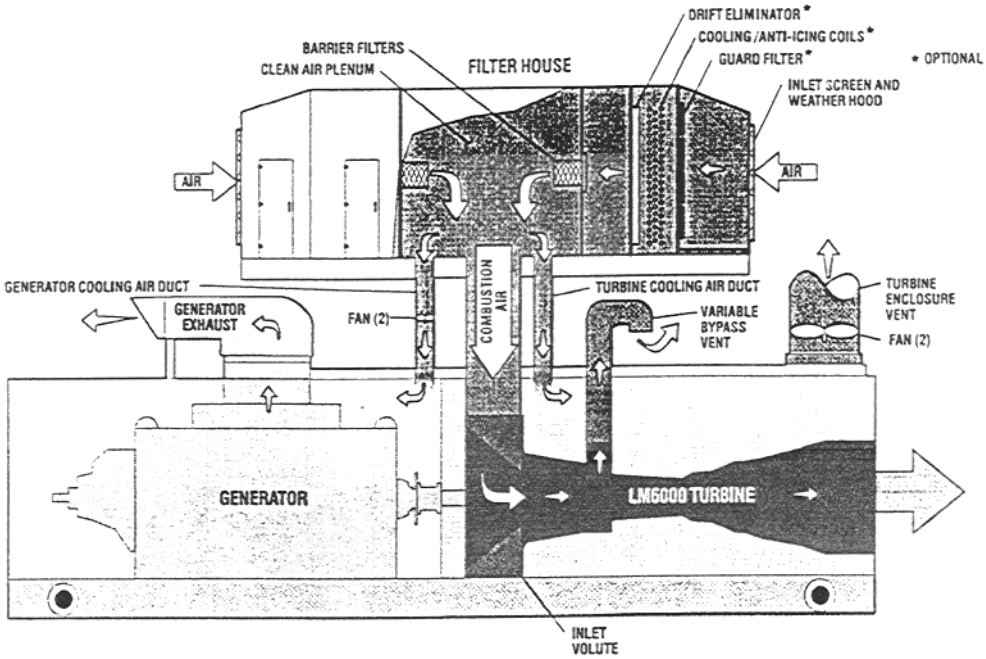
Air Intake System: in order to provide clean, filtered air to the turbine for combustion and ventilation purposes, an air intake system will be mounted on the turbine and generator casings. The system is depicted in Figures 4.1-6 and 4.1-7, next. The system will be modular and composed of a multi-step filtering system comprising a weather-protection device, inlet screens, a pre-filter and a final filter. All air destined to the ventilation system will be filtered with the combustion air for the turbine. Cooling reels will be provided at the turbine inlet, using cooled water in order to cool down the inlet air and increase both the power and the efficiency of each set. Considering the high humidity of Macaé region, a significant volume of condensate will be generated in the turbines. After collection, the condensate will be reused and routed to the clarified water tank of the water treatment system, reducing the volume of water required from Macaé river. An air system right on top of the turbine and generator casings reduces the space required for the equipment and the length of the air intake ducts. The flow within the air compartment is divided into two streams: one of combustion air to the gas turbine and a second one, addressed to ventilate the turbine and generator compartments ;

Figure 4.1-6 – layout of an air intake system mounted on top of the GTG



Combustion And Cooling Air Flow For The LM6000 Package.

Figure 4.1-7 – Air Flow Diagram



Cooling System of Inlet Air: chillers will be used to cool down the inlet air in the turbines. The system will comprise 12 chillers (3 chillers for each set of 4

turbines), 12 cooling towers, circulating pumps, controls / alarms, piezometric/losses make up tank, piping, valves and fittings. The cooling tower make-up will come from the water treatment plant. The tower blow down will be routed to the effluent treatment plant.

A schematic layout of this system is depicted in Fig. 4.1-8.

The chillers (capacity: 2500 ton) are designed for operating close to the atmospheric pressure using R-123 cooling media. The evaporation section operates under vacuum and the condenser operated at a pressure slightly above the atmospheric pressure. The design of the system, using relatively low pressures, minimizes occasional catastrophic leakages – which can occur to systems using R-134A, for instance. The total load of cooling media for every chiller is close to 1680 kg, so the cooling media losses must be lower than 9 kg/year.

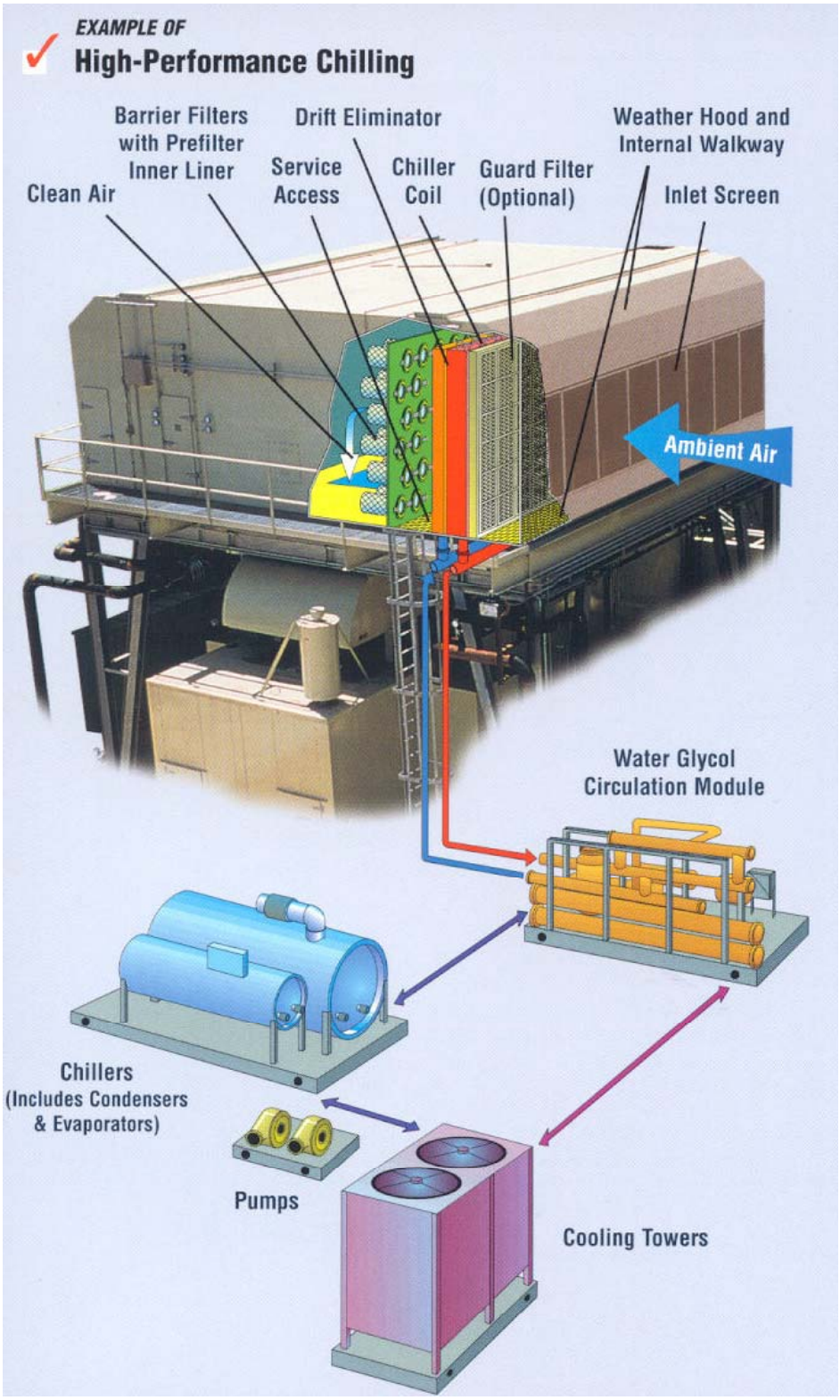
Due to the high-efficiency features and low emission levels, in comparison with other available chillers, the model that will be used was awarded with the U.S. EPA Climate Protection Award.

The cooling media losses monitoring will be performed by photo-acoustic sensors, able to detect concentrations of 1 ppm within the chillers' cabinet (the chillers will be mounted within a thermal-acoustic cabinet);

Water Injection System for NOx abatement: in order to control NOx emissions, water from Macaé river will be used. The water collected at the river will be clarified and demineralized before the injection into the combustors of the turbine. This system will reduce the NOx emissions to a range of 60 ppm, consuming demi water at a rate from 1,05 kg/s through 1,63 kg/s, depending on the room temperature;

Ventilation System: the turbine casing will be provided with a ventilation system comprising two fans for the casing and a third one for the oil compartment.

Fig 4.1-8 – Schematic drawing of the Air Intake System.


EXAMPLE OF
High-Performance Chilling
Barrier Filters with Prefilter Inner Liner
Drift Eliminator
Weather Hood and Internal Walkway
Service Access
Chiller Coil
Guard Filter (Optional)
Clean Air
Inlet Screen
Ambient Air
Water Glycol Circulation Module
Chillers (Includes Condensers & Evaporators)
Pumps
Cooling Towers

4.2 AUXILIARY SYSTEMS OF THE PLANT

These systems comprise the fire fighting and the communication systems, described next:

Fire-fighting System: There will be two fire-fighting systems, one addressed to the fire detection and fighting within the turbine and generator casings, already described (item 4.1), and a second one, composed by a conventional fire-fighting system from hydrants (See Volume 2, Annexes II – Drwg. MEC-150 and MEC-010), described next:

- The fire-fighting water is supplied by the Service Water Storage Tank (See item 5.4). The fire-fighting pumps collect the water at the bottom of the tank, while the industrial water is suctioned from an intermediate section of the tank, at a height that reserves the water at the tank bottoms exclusively for fire fighting purposes.
- Pumping station, comprising 2 centrifugal pumps (230 m³/h, each), at a maximum discharge pressure of 5 kg/cm², electrical and Diesel driven, respectively. The station is also provided with a Jockey pump, which keeps the hydrant network permanently pressurized at 4 kg/cm². As soon as an hydrant is open or one of the deluge units is activated, the electrical pump is automatically activated due to the pressure drop.
- Hydrants network, composed by an underground pipeline ring in carbon steel (diameter: 6 inches) that surrounds the entire industrial area, covering the whole platform where the GTG's and the step-up transformers are installed, with a branch directed to the administration building. In this area, the network will be interconnected to a system of sprinklers of the building and a hydrant will be installed outside the building. The area external to the turbines is covered by 06 (six) hydrants, each of them provided with 2 connections for 2½ hoses. The transformers are protected by individual deluge systems, interconnected to the network.
- Fire-fighting hoses (2½") kept in metallic, red-painted standard cabinets with glass windows, installed next to each hydrant. Every cabinet is provided with four lengths of 15-m long hoses with the respective adjustable nozzles for solid jet and water mist.
- Deluge system for the transformers, interconnected to the network and automatically activated;
- Sprinklers system of the Administration Building also interconnected to the network and automatically activated.
- The stationary fire-fighting system is provided with sound and visual alarm, automatically activated by the functioning of the fire-fighting network. The Plant is also provided with "break the glass" type buttons

located in strategic spots throughout both the administrative and industrial areas.

The design of the entire system is based on NFPA standards and also complies with ABNT codes, where applicable. The system also meets the standards and codes of the do Instituto de Resseguros do Brasil IRB.

Communication System: the communication system of the plant will include direct telephonic lines. A RTU plant will be installed for transmitting the operational data to the closest Energy Control Center of the national operator of the system - ONS. The communication requirements of the ONS will be met by installing the RTU, which will transmit the data by adequate communication media for the locality. Therefore the communication can be performed by microwaves, line conductor or telephone.

Telephone branches (PABX) will be installed in each office and in other selected areas throughout the plant. An attenuator will be installed in these areas to make the utilization of the phone easier.

The telephone system will be a Nortel with 8 phone lines and 32 branches. The system will be expansible in order to receive new phone lines as required.

For network communication, a Cisco 10/100 Mbps hub will be installed with 24 port. The access to internet will be provided by an analogic router, which will make use of two modems and two phone lines for interconnecting to a local ISP.

In addition to the phone system, an internal paging system will be also installed, designed for annunciating general and emergency communications, audible throughout the whole plant area.

A security system composed by up to 8 video cams will be installed for monitoring the control room, main entrance and other vital units of the plant. Within internal areas of the plant, these cams will be installed within explosion-proof compartments. The controls of the cams will be installed at the Control Room and Main Entrance. Two VCR's will record the images.

A radio-communication system will be available in the plant, comprising a main station and 12 radio-transmitters, which will not interfere with the DCS or the control stations.

4.3 DESCRIPTION OF ELECTRIC EQUIPMENT AND CONTROL SYSTEM

4.3.1 MAIN POWER GENERATION EQUIPMENT

4.3.1.1 Gas Turbine

The gas turbine will be a typical pre-assembled GE machine, heated by natural gas and fitted with inlet air ductwork with silencers, inlet air filter, cooled air intake system, lube oil cooling system, outlet duct with silencer and cleaning system for on-line/off-line turbine compressor. The gas turbines (16 units) will include a complete control system, interconnected to the control system of the thermal power plant.

The gas turbines and generators will be both locally and remotely controlled, in this case from the main control room of the plant.

The cooled air intake system will include a mechanical chiller using the proper cooling media. The chillers will be also complete and provided with controls.

The lube oil coolers of the turbine will make use of a closed cooling circuit and air fan blades, for dispersing the heat.

The outlet duct of the turbine is also complete, provided with an expansion joint and a reinforced stack, with a height defined by the requirements of the air emissions dispersion study.

The turbine compartments will be protected against fire by a bottled CO2 system (complete, with a monitoring panel).

Each gas turbine will be connected to an electric generator which, in turn , will be connected in pairs to the transformers.

4.3.1.2 Generators

The generator will be an air-cooled synchronous machine operating at 0.85 power factor lagging and 0.95 leading supplied by Brush and ABB/Alstom. . It will be directly coupled to the gas turbine. The generator will be constructed with class F insulation, with a temperature rise limited to class B, with the following classification 70 MVA, 13.8 kV, 3600 RPM, 60 HZ @ 15ºC.

4.3.2 ELECTRIC SYSTEMS

4.3.2.1 High Voltage System

The plant will be provided with a step-up or generation substation, which will be connected to the interconnection substation which in turn, will be interconnected to the Electric System by means of the 345 kV transmission lines Adrianópolis - Campos de FURNAS, as described at 5.10 – Step-Up Substation 13,8/345 kV, Interconnection between the Substation and the Interconnection Substation to FURNAS Transmission lines (See drawings ARG-010 and ARG-020, Annexes I and III, Volume 2).

There will be a power billing metering at the high voltage side of the step-up or generation substation, provided with bi-directional meters and adequate associated equipment, meeting the technical specifications required by MAE/ASMAE and ONS. The metering data will be transmitted to MAE/ASMAE and ONS via COS (System Operation Center) of FURNAS, through a dedicated communication channel.

The interface between the plant and the Interconnected Electrical System will be performed by the connection substation that, after constructed, will get the Use Grant from FURNAS facilities, according to Resolution 433 of ANEEL, so FURNAS will be responsible for the operation and maintenance of the connection substation.

The interconnection between the plant and the connection substation (and consequently the Interconnected Electric System) considers important issues, such as physical interconnection, communication, protection and tele-protection, aiming at meeting the Network Procedures established by the ONS.

4.3.2.2 Feeding of the Medium Voltage System

Each pair of generators will be provided with an auxiliary step-down transformer (13,8/4,16 kV – 10/12,5 MVA) connected to the bus of one of the generators, which will feed the Auxiliary Service system of the plant and, consequently, the medium voltage system. Considering this configuration, a total number of 8 transformers will be provided.

4.3.2.3 Auxiliary System (Medium Voltage

Eight auxiliary transformers (UAT) must keep the medium voltage system of the plant at 4,16 kV. O The medium voltage distribution system will feed the medium voltage auxiliary systems of the plant (compressors of the cooling

units) as well as the low voltage distribution system, in this case by means of service transformers (step-down transformer 4,16 kV / 480 V).

The distribution system for the auxiliary power will comprise area substations, including distribution mechanisms, MCCs, bars and lighting panels. The respective transformers will distributed in order to achieve a proper distribution of loads.

4.3.2.4 Low Voltage System

The low voltage system of the plant will be fed by step-down transformers (4,16 kV / 480 V; 220-127 V).

The turbine auxiliary elements will be supplied together with the MCCs as part of the turbine suits (one MCC for each turbine).

The distribution of the low voltage system must be cable tray type for the power, control, lighting and instrument circuits. The secondary distribution cables will be installed within rigid steel conduits. Multi-conductor instrumentation cables must be positioned in stair trays. The isolation must be flame retardant type with a low smoke production rate.

4.3.2.5 Emergency Power

The operation of critical loads, as those required during and after a power failure of a plant shut down, must be supplied by an essential bus bar, which will have both a normal and an emergency power source. The emergency power will be provided by a dedicated emergency Diesel motor-generator connected to the conductor by an automatic transference switch. The emergency generator can be periodically tested, not bringing any risks to the plant normal operation.

Typical loads to be supplied by the essential source are:

- Uninterruptible Power Supply (UPS);
- Battery charger for the DC system;
- Emergency lighting;
- Instrumentation supply;;
- Emergency lube oil pumps of the turbines

4.3.2.6 Uninterruptible Power Supply (UPS)

- Acid lead/calcium batteries designed for de DC load profile of the plant during emergency periods (minimum: 3 hours);
- Two high capacity, filtered silicon chargers, redundant, with load sharing capacity and a recharge time between 8 and 12 hours.
- DC distribution panels

Each control system of the GTG will be provided with a 24 V Ni-Cd battery.

4.3.2.9 Lighting

The lighting systems will be supplied by a three-level system. During normal operations, the lighting will be supplied by the normal AC system. In case of a failure of this system, an emergency lighting system will be activated for the critical areas, supplied by the stationary batteries or by the stand-by Diesel generator. In addition to all internal areas, the following external areas will be also provided with lighting systems:

- Transformer;
- Parking areas;
- Operational areas;
- Pumping stations;
- Service areas;
- Valves manifold;
- Spent oil treatment;
- Site roads;
- Water treatment plant;
- Cooling tower;
- Substation;
- Fuel gas handling area;
- Security or monitored areas.

The external lighting will be activated by photocells (automatic on/off switch).

Both internal and external lighting for areas with a strong traffic of personnel, such as the workshop and warehouse areas, will utilize high-pressure sodium lamps with chromatic correction within enclosed light fixtures. Fluorescent lighting will be provided for the following areas: instruments control rooms, offices, laboratories, distribution systems, main entrance and others. The roads' lighting will be composed by lamps into stationary fixtures mounted into stacks. The lighting for open areas with operational activities, close to equipment or platforms, will be composed by protected semi-sphere reflectors. The general illumination of the external areas will be a spot type, from stacks, building walls or other adequate structures.

All light fixtures located in specific areas of the plant will be provided with an instantaneous re-switching system and fed by an essential power system in order to allow the personnel escaping from the area during a black-out or a complete power failure.

4.3.2.10 Ground and Lightning Systems

The plant ground system will be designed according to IEEE Standards 80, 142, and 665 and to ABNT standards. The ground system design will consider the real local grounding conditions. Equipment and steel structures will be connected to the ground system. The piping systems are considered grounded by the equipment to which they are connected. Grounding rods, if used, must be made in zinc-steel or lined with copper. In general, the total resistance to a remote ground of the system must not exceed 5 ohms for the general areas of the plant and 1 ohm for the high voltage substation.

All structures of the plant must be protected, including buildings, towers and stacks. Ground rods or plates must be located on the base of all structures, connected to the ground system,. The main ground cables must be made in copper.

4.3.2.11 Motors

All isolations of coils must be adjusted to tropical climatic conditions, with a Class F isolation (minimum); but the temperature increase must be restricted to Class B isolation figures.

4.3.3 INSTRUMENTATION AND CONTROL SYSTEM

4.3.3.1 Control System of the Plant

The design of the Control System of the Plant will be based on the gas turbines generators (GTG) and on the Balance of the Plant (BOP). The electrical and mechanical auxiliary systems will be controlled from a Central Control Room (CCR) located at the main building of the plant The GTGs will be also provided with local controls.

The main control system should be distributed type comprising PLCs functionally distributed, I/O control cards (input/output), power sources, interface devices, etc., required for controlling, protecting, monitoring, annunciating and obtaining data of the plant.

Systems such as the chillers, demineralization plant, gas analyzers and those belonging to the effluent treatment, continuous emission monitoring system (CEMS) for CO, NOx, SO2, PM, etc. will be controlled by local systems by PLCs, connected to the DCS of the plant.

The control system should be able to interface to the Performance Monitoring System of the Plant, provided with remote access.

4.3.3.2 Interface and Support with the Interconnected Electric System

The control system should be able to communicate with the System Operation Center (COS) of FURNAS and with the ONS thorough the SCADA system (Supervisory Control And Data Acquisition).

4.3.3.3 Control and Monitoring of the Balance of Plant Equipment (BOP)

The control and monitoring of the plant systems will be performed by means of local PLCs linked to the Data Acquisition System of the Plant (DCS).

The control of local systems, supplied with the associated equipment, will interface with the control system of the plant by means of communication data exchange and check of monitoring signals.

Critical systems addressed to the plant operation and shut down require an uninterruptible power supply source. The GTGs are supplied by GE with emergency batteries. The UPS must be a complete, redundant mono-phase system, supplying power to both the emergency shut down system and the DCS system. The batteries of the system must be designed for a load profile and a minimum operational period of two hours. The UPS outlet must be regulated for ± 1 Hz. The UPS will be normally supplied by a low voltage MCC connected to the essential bus bar. A regulating transformer should supply an optional low voltage supply to the UPS by means of a by pass operational mode.

The following loads, related to the plant processes and safety aspects that should be powered by the UPS, are suggested:

- Logical Programmable Controller (LPC)
- Critical systems of the PLCs
- Fire detection and alarm systems
- Critical, safety related analyzers
- Computer systems of the processing package units
- Control panels of the Turbines and Generators

4.3.2.7 Electric Systems for Instruments

The instruments will be supplied by a low-voltage power distribution panel for instruments. The electric system will support the power control panel of the instruments and all instruments that require separate supply, such as watches, analyzers, relays, and solenoid valves.

4.3.2.8 DC Power Supply

A separate DC power supply will be available for each turbine, addressed to the plant supervision and to the high voltage substation.

The DC power supply system must provide a reliable source addressed for the DC requirements of the GTG and for the Balance of the Plant (BOP) regarding the control and power supply functions during both the normal and emergency operations of the plant. Each GTG will have its own batteries and DC systems. Each system must comprise the following main elements:

4.3.3.4 Data Acquisition

A Data Collection/Acquisition feature will be part of the control system of the plant, allowing the storage (short and long terms) and retrieval of data, recording of occurrences and trends of selected areas.

4.3.3.5 Annunciation System

The control system of the plant can generate annunciation warnings in any accessed point. A sequence of events' recording will be available for a wide coverage and supervision of the DCS of the plant.

4.3.4 CATHODIC PROTECTION SYSTEM

A cathodic protection system will be provided in order to protect underground or submerse metallic structures, such as pressurized steel pipelines and the lower part of tanks and vessels. The system will meet NACE standards.

The protection of underground structures, such as insulated ducts and similar equipment presenting relatively small surface areas, magnesium, zinc or aluminum galvanic anodes will be distributed on the structure to be protected.

4.4 MONITORING AND CONTROL PHILOSOPHY

The plant control philosophy is based on a DCS, some stand-alone systems, such as the gas turbine control, and some fully isolated systems, such as the Air Conditioning and Fire-Fighting systems. However, the DCS will control all systems of the plant.

The monitoring functions and controls of the plant, (including auxiliary electric systems) must be supervised and coordinated from a central control room (CCR).

The DCS and the CCR will be designed for operating with a minimum number of people and only an operator and a supervisor are expected for normal operation conditions.

The following functions must be available:

- Closed loop control
- Automatic sequential control
- Protections and interlocks
- Plant supervision

- Data communication
- Data acquisition and storage
- Monitoring of the equipment conditions
- Performance calculations

In addition to this, the DCS will also control:

- Start-up and shutdown of all main pumps.
- Signals, including the status of the substation circuit breakers and insulators
- Start-up and shut-down sequences of the Water Treatment Plant

For the stand-alone system, a minimum integration to the DCS will be provided, as follows.

Table 4.4-1 – Minimum Integration to the DCS

System	Functions in the DCS
Turbines	Total control for both manual and automatic modes. Monitoring and alarms.
Water treatment	Main commands for starting local logical sequences. Monitoring of analogical variables and alarms.
Electric Systems (Medium and Low Voltages	Monitoring of analogic variables. Alarms.
Substation	Control of circuit breakers. Monitoring of the status of analogic variables and alarms of the transformers.
Remainder systems	Normal operation alarms

A local control panel will be installed for each gas turbine, but they will be used only for commissioning and maintenance purposes. All normal operations must be performed from the DCS.

A UPS system will be provided for all instrumentation and control systems, which will be able to keep the systems operating for 90 minutes in case of an interruption on the power supply.

The available automation level in the GTG's will allow the operational personnel the start up, normal operation, interconnection to the network during normal or emergency conditions. In addition to this, it will also allow:

- Automatic controls in case of abnormal conditions that risk the integrity of the plant.
- Supervision and control of auxiliary electric systems

- Load testing for all equipment

The failure criteria of the Control System will follow the following rules:

- No simple failure will cause a complete failure of the control system. Protection controls must use a logic voting system.
- No simpler failure will cause a spurious operation or the inoperation of the protection systems.
- The control system must take in account the redundancy provisions of the plant so a single failure will not cause a failure on stand by equipment.

The data acquisition and monitoring system must follow:

- Post-accidents Reports
- Monitoring of the plant Conditions
- Monitoring of the performance of all systems, from the gas delivery to the energy exportation.
- Analysis of trends
- Historic analysis
- Alarms and storage of data of events with a resolution of 1 ms for at least 96 points
- Total number of start-ups.

An emergency shut-down system will be installed for the plant, addressed to provide an automatic, safe shutdown of the plant in case of abnormal operational conditions that could compromise the safety of the process or cause permanent damages to the plant. Each turbine will be provided with a protection that will activate the turbine shutdown if some critical parameters exceed the maximum allowed values.

Individual items of the plant must be equipped with passive interlocks in order to prevent the improper operation and active interlocks in order to activate the equipment shutdown in case of hazardous operation conditions.

Alarms of the fire or gas detection systems will be available at the CCR. The system will interface the DCS so these alarms can be repeated at the screens of the operation room.

The power metering will include a metering at each generator, an importation/exportation meter at each 345 kV circuit. These meters include MW, MVAR, MWh, MVARh and a sum of MWh and MVARh. The accuracy level must be 0.2. These equipment will comply with the requirements of MAE and ONS.

The gas metering must be performed at each turbine and at the main supply line. Thew meters must be a turbine type, with an accuracy of ±0.25%. This accuracy must be kept for the whole range of gas supply.

5 ENGINEERING PROJECTS

5.1 BUILDINGS AND LAYOUT

5.1.1 OFFICE, CONTROL ROOM AND WORKSHOPS

The main building of the plant houses the General Management and its support areas, such as the Administrative Support, Engineering, Maintenance and Control Room. The building will have two floors, constructed area of 1,800 m², made in metallic structure and bricks, internally divided by incombustible material (vermiculite lined with melanitic material).

The description presented next is based on the detailed drawings.(ARQ-010 and ARQ-020), in Volume 2 - Annex III.

The ground floor houses a Maintenance Workshop, occupying an area of 600 m^2, with an 11-m high sidewall, provided with all machines and equipment required for the maintenance of heavy-duty equipment, including a crane. The Electrical and Instrumentation Maintenance Workshop will be located adjacent to this area, as well as the Warehouse, divided into General Warehouse, Chemicals and Electronics. Sanitary facilities complete the first floor.

The second floor comprises the Main Control Room of the plant and the General Management, including its support divisions (Administration, Engineering and Maintenance). This floor still includes the plant cafeteria, which will be provided with a pantry, only, and equipment such as refrigerator, food heaters, etc. This floor is also provided with sanitary facilities.

All closed, usually occupied rooms will be provided with AC systems, supplied by an Air Conditioning Central, located at the first floor.

The building will house a total number of 60 people, part of them divided into groups working on a 3-shift basis, 8 hours per shift from Mondays through Fridays. During the peak periods, a maximum number of 50 people might occupy the building.

5.1.2 BUILDING AT FURNAS SUBSTATION AREA

In order to serve Furnas operatives and to house control panels, batteries and other devices, a 500 m^2 building will be constructed at the substation area. This building will be provided with 2 bathrooms, which will include sink, shower and lavatory.

5.1.3 BUILDING AT THE SUBSTATION AREA

A bathroom, including sink and lavatory, will be constructed at El Paso substation area, addressed to the needs of operators that might be occasionally working at the area. The sewerage from this bathroom will be treated in a septic tank, as described ahead, in item 5.3.2.

5.1.4 MAIN ENTRANCE

The access to Macaé Merchant TPP facilities will be controlled from a vigilance room provided with two bathrooms (masculine/feminine) with sink, lavatory and shower. The sewerage generated by this area will be treated in a septic tank, as described ahead, in item 5.3.2.

The remaining facilities of the plant comprise the GTG's units and the water/sewerage treatment plant, described at 5.4 and 5.7, respectively. The general layout of the different buildings of the plant is depicted in drawing ARG-020, Annex-III - Volume 2.

5.2 STORMWATER DRAINAGE

The Stormwater Drainage System was designed in order to route rainfalls to 4 collection points located at the edges of the constructed area of the plant. These areas are already integrated to the earthworks' project if the land, as depicted in drawings NT-DREN-001 and NT-DREN-DET-001, Volume 2 - Annex IV, respectively. The collected water will be subsequently routed to existing drainage channels located in El Paso land, which comprise the natural drainage of Macaé river flat bank, contiguous to the plateau where the plant will be implemented. These existing drainages were dredged in the past by DNOS and are presently used for draining the flat bank area of the river, routing the waster to Macaé river.

The constructed area of the plant comprises a rectangle with main axis oriented to N-S e E-W directions. A street surrounds the whole perimeter of the constructed area, except for the areas where the auxiliary transformers and the raw water treatment plant are.

As can be seen in Drawing NT-DREN-001, the area where the plant will be constructed was divided in two halves by the N-S axis, so almost half of the site will drain to East area and the other half to West area. The slope of each half will be 1%. The East half will drain water toward the existing channel of the flat bank of the river and, from this point, directly to Macaé river. The West half will also drain the water to an existing channel which will also route the collected water to Macaé river. The water collected at the plant area will be routed to the drains by means of downward steps, in order to reduce the water velocity. The descent ends at a dissipation basin, constructed with loosen rocks, in order to prevent the erosion of the slope and reduce the incoming energy of the water flow at the flat bank of the river.

Whenever a contamination of the stormwater flow with oil is likely, the water flow will be isolated by concrete curbs and these areas will be provided with specific drainage pathways, which will collect the stormwater and route the stream to water/oil separators, as described at 5.7.1.

The streets that surround the GTG's and water treatment areas will be provided with culverts, designed for the worst rainfall conditions, in order to prevent floods due to downpours at any time of the year.

The design of the stormwater drainage systems of the plant was based on the following criteria:

- ✓ Characterization of the rainfall indexes of the studied area (normal and strong indexes);

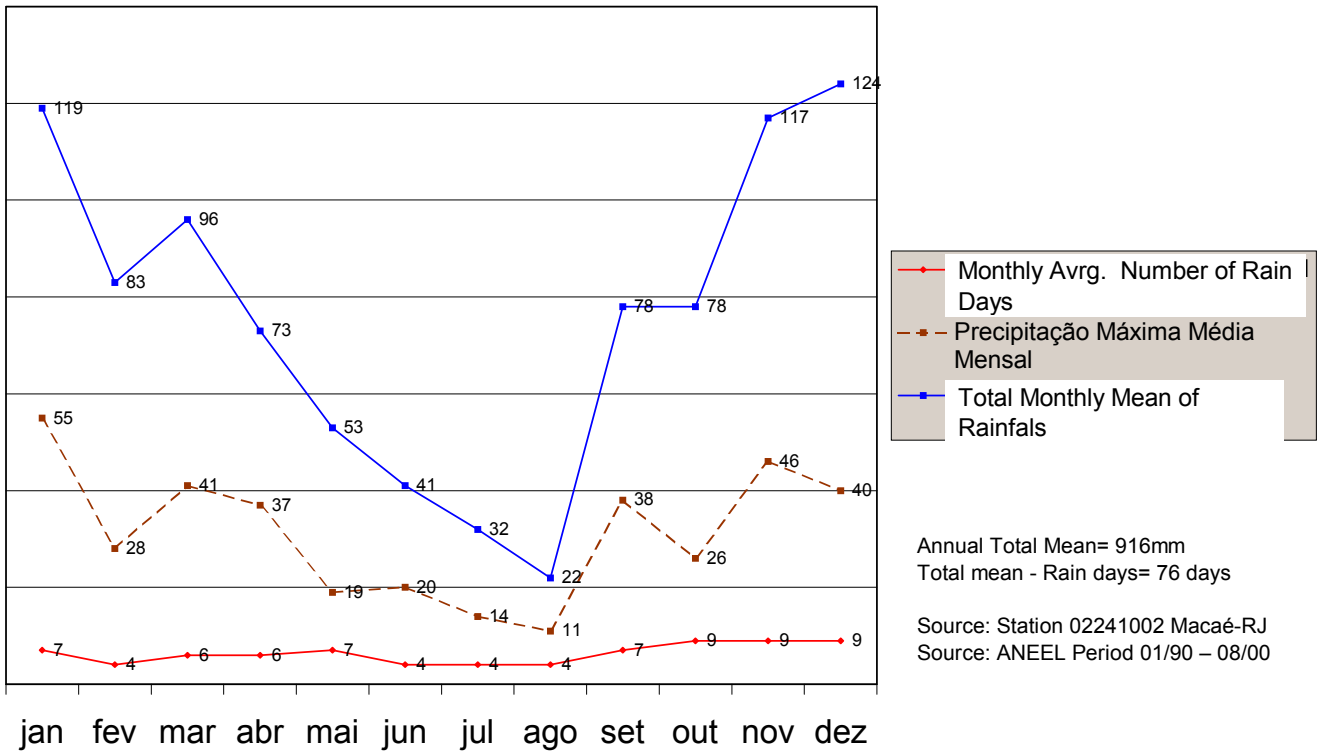
The following elements were used:

– Rainfall data for the period from Jan/90 through Aug/00 – Station 02241002 MACAÉ-RJ. Source ANEEL.
– Rainfall equation of FUNDERJ, based on observations performed for the period 1944-1978

$$I_{mm/h} = \frac{1489 . Tr^{0,221}}{(t_c + 13)^{0,808}}$$

✓ Pluviometry

Based on ANEEL rainfall data, graphs were plotted for maximum monthly means, monthly average number of rain days and total monthly means of rainfalls, as depicted next.



✓ Calculation of Design Flow Rates

The design flow rates were estimated by utilizing the Rational method, by means of the following equation:

Q = 2,78.C.I.Ad

✓ Concentration Time

The initial concentration time used in the calculations was 5 minutes.

The design of the culverts was based on the following equation:

$$T_c = 0{,}95\left(\frac{L^3}{\Delta h}\right)^{0{,}385}$$

✓ Recurrence Time

The recurrence times used in the design were:

– Surface drainage T_R = 5 years
– Culverts T_R = 15 years

✓ Surface drainage

The surface drainage system basically comprises small channels with the following shapes:

– Trapezoidal
– Rectangular
– Semi-circular

In order to prevent erosion, to provide an easier cleaning and to maintain the geometry of the devices, the channels were designed in concrete, except for the natural drains located at the low areas and berms, to which vegetation recovery was indicated.

All flow pathways of the drainage devices of the areas and slopes were designed as water downslopes, steps and collection boxes, in order to prevent the occurrence of erosion processes.

Dissipation basins were suggested for the outlets of the water downslopes and steps.

✓ Design of Devices

Manning formula was used for the hydraulic design of the system, associated to the continuity formula, as defined next:

$$Q = \frac{1}{n} ARh^{2/3}I^{1/2}$$

Q = allowable flow rate of the device m³/s
n = Manning coefficient

n = 0,013 – Concrete lining
n = 0,020 – channels with short vegetation

n = 0,022 – channels with long vegetation

A = Wetted area, m²
Rh = hydraulic radius, m
I = slope, m/m

✓ Deep Drainage

Whenever the land cuts reveal that the water table could affect the stability of the platform of the access roads, a longitudinal deep drainage must be performed, using a perforated pipeline (diameter: 150 mm). Draining material and filtering material (Bidin or similar).

✓ Culverts

The design of the culverts was based on the critical regimen criteria, whose equation for circular culverts is:

$Q = 1{,}533 \text{ ø } ^{2,5}$, m³/s

5.3 SANITARY SEWERAGE SYSTEM

5.3.1 SEWERAGE TREATMENT SYSTEM OF THE MAIN BUILDING

The treatment of the sewerage generated at the Main Building of Macaé Merchant TPP will be performed by an Activated Sludge process, based on both ABNT and US EPA standards, where applicable, or by a septic tank system, either according to ABNT standards or to specific codes of FEEMA. The following criteria will be used for the activated sludge process.

5.3.1.1 Design Criteria

The system will be designed to meet the following criteria and parameters:

Total number of employees	60
Administrative shift	30
Second shift	15
Third shift	15

Equipment: sanitary facilities, showers and cafeteria
Design criteria: 70 liters per employee/day
BOD: 0,039 kg/employee.

The design was based on both ABNT and USEPA standards, where applicable, in order to meet the following requirements:

Parameter.	**Inlet**	**Outlet**
Flow rate (liters/day)	6.000	
BOD (ppm)	300	<15
Suspended solids(ppm)	300	<15
Ammonia Nitrogen (ppm) NH_3	35	<3

5.3.1.2 Description of the Facilities

The Sewerage Treatment Plant of Macaé Merchant TPP, described next, is displayed in drawing MEC-160, Annex V – Volume 2.

The unit was designed for treating up to 6,000 liters per day and comprises a compact plant (5.o m long, 2.5 m wide and 3.0 m high), composed by a Flow

Equalization Tank, an Aeration Tank, a Digestion Tank, a Clarification Tank and a Chlorinator.

Equalization Tank: This tank is intentionally large (6,000 liters), in order to still wide fluctuations of the sewerage flow rates that occur along the day, especially during the change of the shifts. In order to maintain a good culture of bacteria and meet the effluents' specifications, a uniform flow rate is required 24 hours a day.

Submersible Pumps: These are low capacity pumps located at the bottom of the Equalization Tank, which can be manually removed or relocated.

Flow control boxes: Composed by gutters and gates that allow controlling the flow rates to the Aeration Tanks. The maximum design flow rate is 4,2 l/min.

Aeration system of the Equalization Tank: Composed by a submersible, positive displacement blower that insufflates air into the fresh sludge at a rate of 140 l/min.

Aeration Tank: It is a 9,500 liters tank, designed for 6,8 kg of BOD for 28,3 m³, a standard for aeration systems, adequate for meeting the effluents specifications before the disposal.

Aeration system of the Aeration Tank: Composed by two submersible, positive displacement blowers that insufflate air into the activated sludge at a rate of 140 l/min, each.

Clarifier: Designed for a Retention Time of 5 hours, this equipment is responsible for concentrating the suspended solids, releasing clarified water to the Chlorination step and returning the thickened fraction to the Aeration Tank. When the concentration of solids reaches the design limit, the thick phase is sent to the Sludge Tank, or Digester, to be discarded. The sludge transfer is pneumatically performed.

Chlorinator: This unit comprises a 250-liters tank, enough for s Retention Time of 45 minutes, where the treated water is chlorinated, reaching the conditions required for being discharged into the collection network, that will be interconnected to the treated liquid effluents streams, as described in 5.7.

Sludge Collection Tank: Also called Digester, this tank stores and provides the final settling of the sludge before the disposal. The settling is performed by fluidizing the sludge bed with air.

5.3.2 SUBSTATION AND MAIN ENTRANCE BUILDINGS

The treatment of the sanitary sewerage of these buildings will be performed by a small system composed by septic tank , anaerobic filter and infiltration trench, as specified at drawing HIDR-020, Annex V – Volume 2. The system is designed in accordance with the design criteria doe Septic Tanks – Anaerobic Filter for non-residential buildings, based on the procedures at NBR 7229 Standard of ABNT, dated of September, 1993.

The septic tanks were designed for a sludge removal every 5 years. The removed sludge will be dried in a proper area and subsequently used as fertilizer. The use of the sludge for fertilizing potherbs or vegetables that are consumed raw will not be allowed.

The sewerage treatment system is provided with two sets of tanks, whose main characteristics are described next:

Septic Tank

Rectangular, prismatic tank, watertight, horizontal flow, which treats the sewerage by means of a settling-flotation-digestion process;

Anaerobic filter

Rectangular, prismatic tank, impermeable walls and bottom, addressed to the treatment of the sewerage by drowning the biological filtering media;

Cesspool

A distribution system for the effluent of the anaerobic filter, which guides the infiltration of the effluent into the soil.

5.4 WATER TREATMENT AND SUPPLY

The supply of the water required for the operations of Macaé Merchant TPP will be performed from Macaé river. The information on the river water quality provided by FEEMA, RJ for the period 1990-1996 was took in account for designing the system.

This item will describe the raw water intake and treatment systems addressed to industrial uses in the Plant. Physical, chemical and biological characteristics of the water to the collected are analyzed in item 5.7, which presents the environmental description and evaluation of the liquid effluents treatment and disposal systems of the plant.

5.4.1 MACAÉ RIVER FLOW RATES

The following hydrological records are defined for Macaé river at the considered water intake point:

Minimum-recorded flow rate: $Q_{7,10}$ – 5,30 m^3/s (according to the hydrological study presented in item 5.7 ahead)

Maximum recorded water level: 3,60 m – Feb. 1998

Minimum recorded water level: 0,40 m – Jun. 2000

Both maximum and minimum levels were recorded at the river gage upstream the water intake of CEDAE, located 400 m upstream the water intake of MACAÉ MERCHANT TPP.

The water intake of the considered system will comprise a stationary intake structure located at the right bank of the river, close to the point where it crosses BR-101 road, as indicated in the annexed drawing. The system will include a raw water transfer unit, a pre-treatment system, comprising chlorination and clarification steps; the production of demineralized water to the injected into the turbines for NOx emissions abatement purposes and the effluents treatment unit, which will be described in item 5.7.

5.4.2 PHYSICAL, CHEMICAL AND BIOLOGICAL CHARACTERISTICS OF MACAÉ RIVER WATER

The Table presented next summarizes the monitoring data from FEEMA station, located close to the water intake area (MC-02) for the period 1990-1996.

TABLE 5.4-1 – WATER QUALITY AT STATION MC-02 – MACAÉ RIVER

1990 - 1996

PARAMETERS	STANDARD RES. CONAMA 20/86 – Class 2	NUMBER OF DATA	MINIMUM VALUE	PERCENTILE 10%	PERCENTILE 90%	MAXIMUM VALUE
Sample Temperature - ^{o} 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
Dissolved Oxygen – mg/l	5	35	0,1	6,4	8,4	9
Total Filterable Residue– mg/l (total of dissolved solids)	500	2	40	46	94	100
Non-filterable Residue– mg/l (suspended solids)	NR	35	8	10	75	120
Lead – mg/l	0,03	32	0,002	<0,02	<0,02	0,02
Cyanide – 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 Phosphorus – mg/l	0,025	33	0,01	<0,036	<0,1	0,4
Phenol – 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
Nitrite – mg/l	10	11	0,001	0,002	0,02	0,02
Ammonia Nitrogen –mg/l	0,5	35	0,01	<0,01	0,066	0,3
Nitrogen Kjeldahl –mg/l	NR	32	0,15	0,255	0,8	3
BOD $_{5,20}$ – mg/l	5	35	2	<2,0	<5,28	60
Fecal coliforms	1.000 *	36	< 1	ND	ND	34

Source: FEEMA
NR – not regulated; ND – not determined
* Limit for primary contact leisure

It must be considered that the analyzed water presents characteristics that meet Class 2 water bodies, according to Res. CONAMA 20/86, for all evaluated physical and chemical parameters, except for the maximum values of phosphates (expressed as P), nutrients responsible for the eutrophication of water bodies, cyanides and phenol. The maximum limits were exceeded for 90% of the measurements only for phosphates and phenol cases. Since the phosphorus parameter is very important regarding the disposal of the effluents from the plant, which will use phosphate-based anti-scaling and anti-corrosion

agents, it is necessary to mention here the well-known utilization of fertilizers by the agricultural areas existing in the river basin, as discussed in item 5.7.

In a general way, the water quality of Macaé river is good, according to the measurements performed for the aforementioned period, highlighting the relatively low level of dissolved solids, the adequate level of dissolved oxygen, the absence of heavy metals in significant concentrations for most of the samples and a COD level that indicates the absence of relevant sources of organics from human activities, although the indexes of phenol – a parameter which is hard to assess in laboratory analysis for the concentration required by Res. CONAMA 20/86, 1 ppb – presented significant changes in 90% of the samples. Under a biological point of view, the BOD level and the amount of fecal coliforms, indicate a degradations associated to the disposal of untreated effluents into the river basin.

5.4.3 RAW WATER INTAKE

The raw water to be treated will be made available by a intake and transfer system, designed to meet the demands of pre-treated make-up water of the cooling tower and the consumptions of demi water, as well as for the required stabilization of the fire-fighting network.

The water will be collected by 2 centrifugal pumps (one operating and one stand-by), with enough capacity for servicing the flow rate required by the process, 360 m^3/h.

The water intake will be performed in an area located at the right margin of BR-101 to Rio de Janeiro direction. This area is displayed in the topographic map (Annex). The water intake will be located 100 m downstream the area destined to the disposal of the treated effluents of the plant.

The water intake of MACAÉ MERCHANT TPP will be composed by three main structures, as described next :

a) Upstream Structure

Addressed to collecting water from Macaé river, this structure will be installed at the right margin of the river and constructed of reinforced concrete. The pipelines that will take the water to the settling tanks will be fixed in this structure, comprising two steel pipes (diameter: 400 mm and upper generatrix at elevation 0,40 m).

The upstream structure will be provided with stationary steel grades, addressed to restrain coarse materials carried by the water.

b) Settling Chambers

Located 40.0 m far from the upstream structure and constructed of reinforced concrete, the settling chambers will be responsible for separating silty and sandy sediments carried by the water before pumping it to the water treatment. The separated sediments will be subsequently removed.

The system will comprise two impervious chambers with a pipeline system designed for allowing the isolation of one of the chambers for the removal of sediments.

c) Pumping Station

The pumping station will be coupled to the settling chambers, constructed of reinforced concrete and able to pump water at a rate of 363 m³/h to the water treatment plant, located in the site area.

The pumping set will be composed by 2 pumps, with 100% of their rated capacity.

The pumps will be work drowned, protected by valves installed upstream them.

Immediately downstream the pumps, at the transfer pipelines, check valves will be installed for protecting the pumps against water hammers due to a power failure.

The pumping station will be provided with a double electrical supply, so the pumps can be activated from the electric system of the local concessionaire or from the auxiliary electric system of the plant.

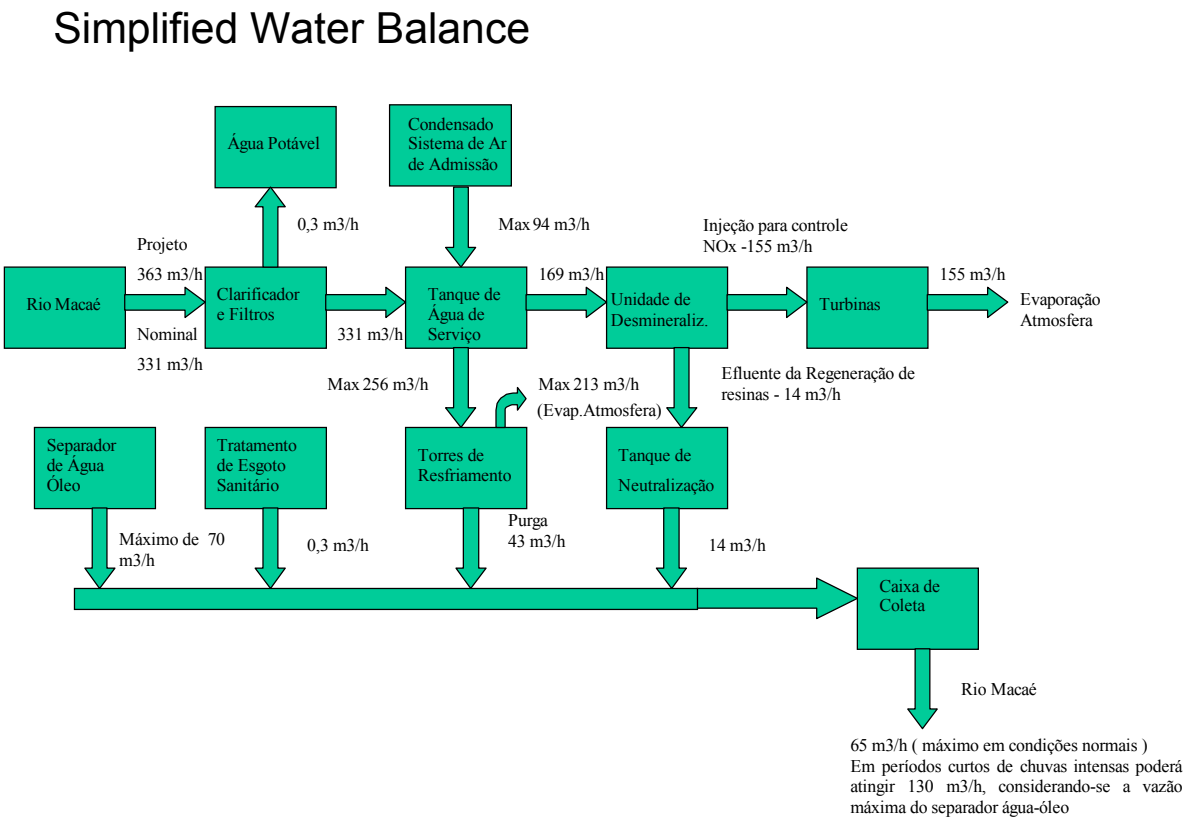
All water intake structures will be located at the elevation 4.5 m, which will prevent them to be affected by the river floods, whose available records indicate a maximum flooding level of 3.6 m.

The layout of the aforementioned structures, including the pipelines from the upstream structure on, is displayed in drawing BRJ034-4C0020, Annex V - Volume 2.

5.4.4 WATER UTILIZATION

Figure 5.4-1 next displays a block diagram with the main components of the Water System of Macaé Merchant TPP

FIGURE 5.4-1 – Water Flow Diagram –Macaé Merchant TPP



Legenda:

Água potável = Potable water
Condensado do sistema de ar de admissão = condensate from the air intake system
Injeção para control de NOx = Injection for NOx abatement
Rio Macaé = Macaé river
Projeto = Design
Nominal = rated
Clarificador e filtros = clarifier and filters
Tanque de água de serviço = service water tank
Unidade de Desmineraliz. = Demineralization Unit
Turbinas = Turbines
Evap. Atmosfera = Evap. To the Atmosphere

Efluente da Regeneração de Resinas = Effluents from the Regeneration of Resins
Separador Água-Óleo = Water-Oil Separator
Tratamento de Esgoto Sanitário = Sanitary Sewerage treatment
Torres de Resfriamento = Cooling Towers
Tanque de Neutralização = Neutralization Tank
Purga = Blow down
Caixa de Coleta = Collection Box
65 m3/h..... = (maximum, under normal conditions. For short downpours, it can reach 130 m3/h, considering the maximum flow rate of the water-oil separator)

Considering cooling down the wet air intake at the turbine, a condensation is expected to occur, taking to an additional generation of clean water that can be used to meet the water requirements of the plant. This water will be collected and sent to the service water tank. The flow rates of condensed water will depend on the existing climatic conditions (temperature and relative humidity) and are estimated by 94 m^3/h, average.

5.4.5 WATER TREATMENT

The water treatment will comprise two steps described next: pre-treatment and demineralization. The general layout of the Water Treatment Plant is depicted in drawing MEC-020, Annex VI, Volume 2.

5.4.5.1 Clarification

The raw water will feed a DensaDeg® commercial clarification equipment, whose system is displayed in the preliminary flowsheet (drawing MEC-050, Volume 2 - Annex VI). This clarifier is a units that has been successfully used for removing suspended material from water, presenting some advantages when compared to conventional clarifiers, such as a compact design (requiring 50% less space than the conventional units), the formation of a sludge from 5 to 10 times thicker than the conventional ones, optimization of the utilization of chemicals and not requiring the sludge concentration step. As a main result, the DensaDeg® is able to produce water with a concentration of total suspended solids lower than 1.0 mg/L for most cases.

Among all existing standard DensaDeg® units, a 360-m3/h unit was selected. A coagulant with a maximum dosage of 50 mg/l of $FeCl_3$ will be used as primary coagulant. Liquid polymer (1 to 2 ppm) will be required for flocculating the hydroxide and the solid produced within the DensaDeg®. Sodium hypochlorite will be also added as a pre-oxidizing agent, for dissolving organics and iron while playing the role of a disinfecting agent also. A control valve will vary the flow rate of the clarified water to be sent to a clarified water storage tank. Flow meters will control the addition of iron hypochlorite, coagulant and polymers.

The sodium hypochlorite will be added upstream the mixing tank by a dosing pump (maximum capacity: 500 ml/min). The coagulant will be added at the tank inlet by another dosing pump (maximum capacity: 700 ml/min). The liquid polymer will be added within the reaction zone of the DensaDeg ®. The mixing tank will be a carbon steel tank (diameter: 1,8 m, height: 5 m). The retention time is 2,2 minutes. An electric driven mixer provides the mixture between the water and hypochlorite / polymer.

DensaDeg® is nothing more than a reactor–turbine equipment. The reactor is a vessel (diameter: 3.3 m, height: 5.0 m). A plug-flow reactor will be provided and positioned in the center of the equipment, in order to provide the proper recirculation and flocculation of the material. An electric-driven axial flow turbine will provide the mixture, flocculation ands recirculation of solids.

The clarifier-thickener is a second vessel (diameter: 5 m, height: 5 m). The internal mechanism comprises a thickener rake and a central rake within the

compartment from where the sludge is removed. Several sampling spots will allow collecting samples for manual tests purposes.

The sludge produced at DensaDeg ® is removed and pumped by diaphragm to a press filter (See flowsheet MEC-040, Annex VI – Volume 2). The filter will be installed on a mezzanine floor, so the liquid will flow back gravitationally to the DensaDeg ®. The produced cake is dried and stored as a solid waste, whose final destination will be evaluated according to Res. CONAMA 06/88 and the associated state codes, aiming at an adequate final disposal of the waste. According to the characteristics of thew river water and to the chemicals to be used in the treatment process as described here, the sludge generated by the clarification of Macaé river water must be classified as Class II and it will be sent to a facility licensed by FEEMA that will provide its final disposal.

The press filter was designed for meeting the following criteria:

Solids produced at DensaDeg ®:

Maximum inlet flow rate: 360 m^3/h
Maximum content of suspended solids: 100 mg/l
Ferric Chloride: 50 mg/L (as $FeCl_3$, $6H_2O$)
Produced precipitate of Iron Hydroxide: 20 mg/l (as $FeOH_3$)

Total dry solids/day

Max: 950 kg

The produced sludge will be transferred to a covered compartment located close to the Water Treatment Plant and, after the plant start up, this sludge will be analyzed and its final destination will be properly defined according to its classification.

The water processed at the DensaDeg ® will be then submitted to a filtering step, the final step of the pre-treatment, after which it can be sent to the Potable Water Supply or to the Service Water Tank. This tank will also receive the condensate from the Air Intake System of the Turbine. The water of this tank will be destined for the following basic uses:

- Make-up water of the cooling towers which will be responsible for cooling down the turbines' air intake, producing condensate;
- Production of demineralized water;
- Fire fighting system; and
- Sanitary purposes;

The water will be filtered by multi-media vertical filters (2 filters, one stand-by, diameter: 3,6 m, height: 1,8 m, each). The internal surfaces of the filters will be lined with epoxy. The filters have a 45 cm-thick layer of sand and a 45 cm-

thick layer of anthracite. The filters are designed for a filtering rate of 180 m^3/h and they will be cleaned by back-washing process. The wastewater from the washing step will be stored in a tank and subsequently sent to the effluents' treatment plant described in item 5.7 ahead.

Consumption of Chemicals

Considering the maximum operational capacity (360 m3/h of water intake, 170 m3/h at the demineralization/neutralization plant and 256 m^3/h for the make-up of the cooling system), the typical consumption figures of chemicals will be:

For the clarification, demineralization and neutralization processes:

- ✓ 15% of NaOCl solution — 350 l/day @ 5ppm of residual chlorine
- ✓ 35% of FeCl3.6H2O — 1000 l/day @ 50 ppm
- ✓ Polymer — 9 kg/day @ 1 ppm
- ✓ 93% H2SO4 — 1220 kg/day
- ✓ 100% NaOH — 840 kg/day

For the cooling system:

- ✓ 50 ppm of Depositrol PY5206 (AEC – inhibitor of scaling for CaCO3, inhibitor of corrosion for carbon steel). Consumption : 1.512 kg/month
- ✓ 13 ppm of FloGard MS6208 (zinc – inhibitor of corrosion for carbon steel). Consumption: 393kg/month
- ✓ 30 ppm of Dianodic DN2303 (HPS-1 – dispersing agent for Iron, Zinc, turbidity, etc). Consumption: 910kg/month
- ✓ Spectrus NX1106 (isotiazolina – non-oxidizing biocide). Half-monthly shock dosage of 70 ppm - 420 kg/month (11.520 m3/h circulating, total volume of approximately 3.000 m^3)

5.4.5.2 Demineralization

The water supply for this treatment step is performed by the demineralization pumps from the clarified water tank. The process is performed as follows:

First Step: Cations exchange - CO_2 removal

The demineralization pumps send the water stream through adequate process lines through activated coal beds to a vessel filled with a cation exchanger resin, with a spare capacity of 100%, where the exchange reactions take place.

The acid effluent from the cationic exchanger is then sent through ebonite lines to conventional degassing towers, where CO_2 is removed. This step is applicable when the usual content or carbonates in the water requires the removal of the gas. After this step, the cation-free water is stored in an intermediate tank (cation-free water tank) from which the auxiliary demineralization pumps feed the remaining steps of the process.

Second Step: Anions Exchange

He auxiliary pumps send the cation-free water through pipelines designed in accordance with the acid characteristics of the streams to a vessel filled with an anion exchanger resin, where the exchange reactions take place.

The effluent of this exchanging bed, therefore, will be demineralized water, which is then sent to a final treatment step, in order to ensure its extreme purity.

Third Step: Final Polishing

This step is performed by means of an ionic exchange process that takes place within mixed bed resin exchangers, filled with anionic, cationic and inert resins, which optimize the separation of the resins during the regeneration of the beds. All ions that remained from the previous treatment steps will be retained in this bed.

The effluent from the mixed bed exchangers is then routed to the demi water tank, which is designed for a minimum storage time corresponding to 12 hours of operation of all turbines at the maximum consumption rate.

Regeneration of ionic exchangers

The operational cycle of the ionic exchangers will be automatically supervised and the regeneration of the beds will start whenever their exchanging capacity reach a saturation level, which can be checked by monitoring the following parameters/conditions:

- ✓ Monitoring the totalized flow of treated water, in accordance with the conditions specified by the design of the demineralization plant.

- ✓ Increase on the pH of the effluent, for the cationic exchangers; and

- ✓ Increase on the conductivity of the effluent, for both anionic and mixed bed exchangers.

For any of these cases, monitors of limit values trigger the shutdown sequences of the depleted exchangers, activating the respective alarms and informing the operators so they can start the procedures required for regenerating the depleted beds. The regeneration procedures are similar to the operations performed during the production step.

Quality of the Produced Demineralized Water

The system described above will produce demineralized water in accordance with the following requirements:

The water must present particulates with a maximum size of 20 μ.

Item	Limit	Testing method
Maximum total particulate matter, ppm	5	ASTM D5907
Dissolved solids, ppm, max.	3	ASTM D5907
pH	6.0 - 8.0	ASTM D1293
Conductivity, μmhos/cm at 26 °C, max (1)	0.5 - 1.0	ASTM D1125
Sodium + potassium, ppm,max	0.1	ASTM D4191 & ASTM D4192
Silica dioxide, ppm, max.	0.1	ASTM D859
Chlorides, ppm, max	0.5	ASTM D512
Sulfates, ppm, max.	0.5	ASTM D516

Notes: (1) pH and conductivity measured after the removal of CO_2

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. This system is detailed in item 5.7.

Potable Water Supply System

Treated water addressed to bathrooms and sinks will be supplied from the clarified water tank. A maximum consumption of 0,3 m3/h is expected.

All potable water consumed in the plant will be bottled (20 liters) and supplied by vendors. These bottles will be installed in cooled fountains.

The engineering drawings listed next compose the Water Treatment and Supply System and are presented in Volume 2 - Annex VI:

1. Water Intake – Localization Plan (Drwg. BRJ034-4C0010)
2. Water Intake – Layout (Drwg. BRJ034-4C0020)
3. Water Treatment Plant – General Layout (MEC-020)
4. Clarification System (Drwg. MEC-050)
5. Sludge Feeding System (Drwg. MEC-040)
6. Make-up Water (MEC-030)
7. Mixed Bed Units (Drwg. MEC-060)
8. Multi-media Filters (Drwg. MEC-070)
9. Caustic Regeneration System (Drwg. MEC-080)
10. Demineralization – (Drwg. MEC-090)
11. Activated Coal Filters (Drwg. MEC-130)
12. Demineralization – (Drwg. MEC-140)

5.5 WATER INTAKE PLAN – MACAÉ RIVER

5.5.1 PRESENT STATUS

Macaé river basin comprises approximately 1.765 km^2, bordering part of Macabu river basin to north, São João river basin to south, Bacacu river basin to west and the Atlantic Ocean to east.

The basin covers a large part of the municipality of Macaé and part of the municipalities of Nova Friburgo, where the river springs are located, and Casimiro de Abreu, Rio das Ostras, Conceição de Macabu and Carapebus. Almost 82 % of the basin area are located in the municipality of Macaé.

Former Bagres' river, Macaé river starts at Macaé sierra, close to Tinguá Peak (elevation: 1.560m), in Nova Friburgo. The river runs through 136 km, flowing into the Atlantic Ocean, close to the city of Macaé. The main affluents of the river at its right bank are the rivers Bonito, Purgatório and Pedrinhas; the creeks Abacaxi and Carão; Teimoso river, the creeks Roça Velha and Belarmino and Três Pontes river. The main affluents at the left bank are the rivers Sana, Atalaia, São Domingos, Santa Bárbara, Ouro Macaé, São Pedro and Jurumirim and the creeks Genipapo, Guanandirana and Sabiá.

DNOS trained a 25 km-long stretch of the lower Macaé river and performed the same works for some tributaries of São Pedro river and other water bodies (SEMADS, 2000).

Macaé river basin, together with Lagoa Feia basin and the adjacent Coastal Zone, compose the Macro-Environmental Region Nº 5 – MRA-5 of Rio de Janeiro state, located at the southeast area of the state a bordering the following basins: Paraíba do Sul river basin (to north and west); São João river basin (to south) and the Atlantic Ocean (to east).

ANEEL runs three fluviometric stations in the basin. These stations are listed next, related to the respective long-term average flow rates.

Table 5.5-1 – Fluviometric Stations at Macaé River Basin

Code	Station	*RIVER*	Coordinates		Area (km^2)	Flow rate m^3/s	Period
			Lat	Long.			
59120000	Macaé de Cima	Macaé	22º 22'22"	42º 27'44"	67	2,73	05/67-12/95
59125000	Galdinópolis	Macaé	22º 22'09"	42º 22'46"	101	4,44	08/50-12/95
59135000	Piler	Bonito	22º 24'21"	42º 20'18"	75	3,46	08/50-12/95

Studies on water resources performed for the development of the Directing Plan on Water Supply for Região dos Lagos, Macaé and Casimiro de Abreu (CEDAE, 1989), indicated a minimum flow rate of 4,87 m^3/s ($Q_{7,10}$) for Severina station, obtained from a regionalization curve of the minimum

streamflows. Severina station corresponds to the point where BR-101 crosses over Macaé river, downstream Macaé city water intake (CEDAE).

In another spot upstream Macaé river, in the locality of Ponte do Baião (where RJ-162 crosses over Macaé river, upstream the confluence with Purgatório river), the same studies estimated a minimum flow rate $Q_{7,10}$ of 3,61 m^3/s, also based on regionalization curves of minimum streamflows.

More recent studies, performed by SEMADS for the Projeto Planágua (2000), establishes for Severina station a $Q_{7,10}$ value of 5,3 m^3/s and a minimum observed flow rate of 3,85 m^3/s for Macaé river. For the purposes of the present study, a minimum streamflow of 4, 87 m^3/s will be used, which comprises the most conservative figure regarding water resources for the river. This value was obtained at the Water Supply Directing Plan of CEDAE..

The main use of the waters in Macaé river basin is the public supply. According to the aforementioned Directing Plan, there are presently two water intakes in Macaé river: tone located at Ponte do Baião, which serves the cities of Rio das Ostras and Barra de São João, and Severina's water intake, which serves Macaé and Barra de Macaé

According to that Plan, and considering the population growth projected for year 2012, these cities would continue to be supplied by Macaé river, considering some alternative intakes to be performed in Ponte do Baião and Severina.

Macaé is presently supplied by the main water intake of Severina, with a capacity of 370 l/s and an estimated future expansion for 600 l/s, according to the regional superintendence of Macaé. Another small water intake that serves Macaé is performed in Atalaia creek, which supplies water at a rate of 20 l/s. This water intake is located upstream Severina one. The water supply of Rio das Ostras and Barra de São João is provided by a water intake of CEDAE performed in Macaé river, in Ponte do Baião, which must be expanded to 200 l/s, according to the Concessionaire. CEDAE Directing Plan considers that Macaé river resources will be able to supply water to the municipalities presented served by CEDAE, in a safe way, for the next 15 years. Another alternative considered for the river is damming Macaé river at the elevation 600m, which would allow a streamflow regularization at a rate of 9,60m^3/s.

Other important water users located in Macaé river basin are Petrobrás, with a present collection of 167 l/s from Macaé river and Norte Fluminense TPP, which has not been implemented yet, but with a concession for water utilization at a rate of 300 l/s. The water intake of the first industry is located upstream the area considered for Macaé Merchant TPP intake, while the second one is located downstream this area.

EL PASO RIO CLARO LTDA. has requested to SERLA (10/25/2000 - See Annex) the grant for the water collection from Macaé river. The process has been already theoretically approved, which confirms the local water availability. The process is presently waiting for the approval of the state government.

Nevertheless, since El Paso intake will be located at one of the last areas of the free of the salt-water intrusion and downstream the water intake addressed to public supply, it will not affect those users, who are chartered by law as the first priority users regarding water supply during the dry season.

5.5.2 PROPOSED SYSTEM

As described in item 5.4, the water intake will be performed by 2 centrifugal pumps (one operating and one stand-by) with enough capacity for meeting the flow rate required by the process (360 m^3/h)

The water intake will be performed in an area located at the right margin of BR-101 to Rio de Janeiro direction. This area is displayed in the topographic map (Annex). The water intake will be located 100 m downstream the area destined to the disposal of the treated effluents of the plant.

The water intake of MACAÉ MERCHANT TPP will be composed by three main structures: the upper structure, addressed to the water intake, two settling chambers and the pumping station. These structures were already described in item 5.4.2.

5.6 CHARACTERISTICS OF THE CONSTRUCTION SITE

5.6.1 LOCATION OF THE CONSTRUCTION SITE

The location and layout of the construction site are presented in the corresponding annexed drawing at the end of this section. The main facilities of the construction site are numbered in this drawing, and the corresponding areas of each building/areas are listed in Table 5.6-1 next, according to those reference numbers:

Table 5.6-1 – Construction Site Facilities

Reference Number	Facility	Area (m^2)
1	Cafeteria	400
2	Bathrooms	39
3	Training rooms	400
4	Entrepreneur's office	160
5	Administration Office	512
6	Management Office	513
7	Contractors' office	160
8	Contractors' office	160
9	Contractors' office	160
10	Warehouse	39
11	Sentry box	9
12	Storage Area	2500

Note.: (Refer to the annexed drawing)

As can be observed, the construction site is located safely far from the existing water bodies, in order to ensure that sediments or other substances will not be carried toward these bodies.

No refueling areas will exist in the construction site. Commercial fuel distribution stations will be used for refueling vehicles.

5.6.2 GENERAL CHARACTERISTICS

The construction site was designed in order a provide functional, comfortable and safe facilities. It will be aesthetically compatible with the area where it will be installed, composing a harmonious set, signaled according to clear, comprehensive communication standards. None of the site elements will be extemporary or constructed using extemporary methods, such as barracks or similar substandard housing.

The whole construction site will be fenced and the access will be controlled from a sentry box, in order to avoid the entrance of animals or unauthorized personnel.

The area will be properly urbanized. The vehicles access areas will be signaled and covered in order to avoid water pooling and the formation of mud during rainy days, or dust, during dry periods.

5.6.3 CHARACTERISTICS OF THE FACILITIES

5.6.3.1 Office and Support Facilities

These units comprise:

- Offices (entrepreneur, management and administration);
- Bathrooms;
- Workshops;
- Warehouse;
- Sentry box.

The offices will be provided with air conditioning systems and fans, in order to keep temperature and noise levels within comfort and productivity standards. All windows and doors will be provided with framed screens, in order to keep out insects.

The workshops and areas for washing vehicles will be provided with devices addressed to separate and collect oil and/or acids that occasionally spill. The ground will be cemented in these areas in order to prevent the absorption of oil into the soil .

Bathrooms will be transportable-type, installed in metallic containers, in a number enough for satisfactorily servicing the expected amount of users. In addition to lavatories, installed in closed, individual cells, urinals and washstands will be also provided. The water and sewerage facilities of the sanitary facilities will be independent and externally served. The water tank for flushing purposes will be periodically refilled by a truck. The septic tank will be cleaned as required by contracted companies.

All yards addressed to uncovered storage of materials, as well as sheds, addressed to the storage of materials that need to be sheltered, will be organized and designed in order to allow a safe handling of the materials with no risks to the involved personnel.

5.6.3.2 Infirmary and Security Facilities

An infirmary and an ambulance will be provided in order to ensure first aid and primary medical care to the whole personnel of the construction site, 24 hours a day.

The infirmary will comprise the following rooms, all designed with areas compatible with the expected number of people to be tended:

- Waiting room;
- Doctor's office;
- Immunization, dressing, sterilization and drugs storage areas.

The ambulance will count on a private parking area, covered and located next to the infirmary.

The infirmary will be operated by skilled personnel, in a number compatible with the personnel to be tended. The area will be conveniently furnished and equipped with the material required for first aid purposes, stored in a first-aid satchel that must be permanently at hand. In addition to material and equipment, the satchel must also contain a first-aid manual and a map indicating available areas for applying antivenin medication.

More complex cases, such as urgencies/emergencies, hospital admittance and laboratory testing will be provided by the regional public health care service or by contracting private services for this purpose. The construction site will also count on a plan for removing injured people, comprising the utilization of alternative vehicles for this purpose (private, contracted or provided by the public health service), which will be occasionally applied when the ambulance is not available.

At the start of the construction works, it will be demonstrated to the Entrepreneur's Supervision that all covenants and services implemented at the construction site cover all employees and all possible and predictable evens. It will be also demonstrated that the existing planning does not imply on an overload to the local health infrastructure.

The labor safety team will make use of a specific room, which will be properly furnished and equipped.

5.6.3.3 Lodging

Although no lodging facilities are expected in the construction site, the requirements listed next are addressed to the locker rooms, to be installed in the construction site, and to resting facilities that might be occasionally installed in other areas. The design, construction and furnishment of these facilities must meet standards NR-24 and NR-18, item 18.4, regarding the basic purposes of resting areas and/or locker rooms.

Their construction must meet the following main requirements:

- These facilities must use the same materials, finishing and appearance of all pother buildings/facilities;
- The windows must be provided with framed screens, as well as the roof, if no ceiling is provided;
- The facilities must be provided with showers separated from each other by stationary walls;
- The facilities must be provided with individual lockers for all employees;

5.6.3.4 Cafeteria

The cafeteria will be designed for servicing 250 people simultaneously. The building will be constructed with the same material of other buildings of the site, following the same finishing and appearance patterns. The cafeteria will be fitted with air conditioning devices and its doors and windows will be provided with screens for keeping insects out. The cafeteria will be provided with water supply in order to meet cleaning (washing dishes and the floor), hygiene (washstands) and potable water (fountains) requirements.

The meals will be supplied by specialized companies that will serve them properly warmed. The meals will be served in shifts, as required, in order to serve all employees.

5.6.3.5 Water and Sewerage Facilities

Water Supply

The water requirements of the construction site will be supplied by the public water service of Macaé, by means of water-trucks, coming from the water intake of the public supply system.

The water tanks will be good quality ones, provided with lids and with volumes compatible with the expected utilization requirements of the system. The whole supply system, specially the water tanks, will be protected against contamination.

Sewerage

The sewerage system fort the sewer generated at the bathrooms will be straightly connected to the septic tanks systems, followed by anaerobic filters, so the final effluent will present an efficiency of 80% on the BOD removal. The septic tanks will be cleaned as required, by specialized companies contracted for this purpose.

The remaining wastewater will be collected and directly routed to cesspools, since they will not contain any sewerage streams. No open trenches will be

allowed, as well as the interconnection of the sewerage system to the stormwater drainage system.

5.6.3.6 Electric Facilities

The electric facilities will be performed in accordance with item 18.21 of NR-18.

The lighting level of each area will be compatible with the activities performed in these areas, in order to provide safety and comfort to users.

The power distribution network will meet ABNT standards. The shells of all electric equipment will be grounded.

5.6.3.7 Fire Fighting Facilities

All facilities will be constructed in accordance with standards NR-18, item 18.26 and NR-23, regarding fire fighting and protection requirements.

All facilities of the construction site will be provided with enough fire extinguishers, adequate to the fire classes that could occur in the areas, installed in clear, visible areas, provided with good signaling elements. The extinguishers will be distributed so the maximum routes will be 10-20 m, which meets item 23.15 of NR-23 standard.

Stand-by extinguishers will be provided for replacing those that are sent to inspection or recharge.

All extinguishers will be identified for the expiration date of their inspection and charge.

5.6.4 OPERATION OF THE FACILITIES

5.6.4.1 Operational Procedures

A brief description of the operational procedures to be followed in the construction site and its systems is presented next.

A) WATER AND SEWERAGE FACILITIES

All water tanks ands reservoirs will be washed and sanitized every 4 months.

Whenever justified, the water potability will be checked regarding domestic and consumption purposes. Samples, essays and certifications will be performed by a skilled, sound institution.

Lavatories and bathrooms will be washed and disinfected at least two times a day.

Any leakages, especially sewerage ones, must be immediately repaired.

The septic tank will be periodically cleaned by a skilled company.

B) FIRE FIGHTING

The fire extinguishers will be often inspected regarding:

- Conservation conditions (nozzle, hose, trigger, support, etc.);
- Charge and validity;
- Validity of the extinguisher (shell);
- Type, amount and proper positioning;
- Free access.

The safety standards to be implemented and taken will define the storage areas of tires, oil drums, tools and other materials, especially flammable or combustible ones.

Offices, locker rooms and cafeteria will be provided with battery-powered emergency lighting so the utilization or candles, oil lamps or other lighting media that could cause fire can be restricted to inevitable situations.

C) FEEDING AND CAFETERIA

The cafeteria facilities will be permanently kept in perfect hygiene conditions.

The safety standards to be followed do not allow the employees to cook their own meals or mailing use of extemporary heaters or stoves. The utilization of water from rivers and lakes will be also prohibited.

The meals to be supplied to the workers (contractors) will follow adequate hygiene standards, being nutritionally balanced in accordance with the activities performed by the workers. All meals must be prepared on the same day they will be consumed, kept into tightly closed packages and transported to the area into thermal containers, in order to maintain their temperatures.

Potable, filtered and cooled water will be provided to the workers by fountains located close to the work areas.

D) GARBAGE

Garbage, wastes, food leftovers and industrial wastes must be placed into adequate containers, provided with lids and positioned either at the working areas and the construction sites/lodging areas, in order to keep these areas permanently clean.

According to Resolution CONAMA 257/99, batteries and similar wastes cannot be disposed or incinerated. These wastes must be separated from the common garbage and sent to any establishment responsible for their commercialization, which have the duty of receive this material and send it to the manufacturers or importers, which will provide their final destination.

The collection of garbage at the construction site and its transportation to the final destination will be performed regularly in order to prevent the proliferation of animals and bugs, especially disease-inducing ones. Burning garbage will not be allowed in any area of the site. The transportation of garbage will be performed by adequate trucks, in order to prevent the wastes to be scattered around or the spillage of leachate along the transportation the route.

E) SENTRY

Especial care will be given to training sentries regarding environmental preservation issues considering that, in opposition to other workers, the sentries remain long periods by themselves in the site. The training will highlight prohibitions related to hunting, fishing or collecting vegetable or animal specimens.

F) MISCELLANEOUS

The construction site as a whole, including all its facilities, such as offices, workshops, warehouse, cafeteria, bathrooms, yards, parking areas, sentry boxes and any other used areas, will be kept orderly, neat and under good conservation conditions.

The silence law must be respected regarding noise generation. The limit period (from 7 AM to 10 PM) must be respected. Any changes on this period, regarding special and localized situations, must be previously approved by the Entrepreneur's Supervision.

5.6.4.2 Medical Tend and Safety

The site will be provided with specialized services addressed to Labor Safety and Medicine, properly registered at the Labor Ministry, which will be fully responsible for the safety, hygiene and medicine conditions of the workers, as considered by Law 6.514, dated of December 22nd, 1977 and by the Directive 3.214, dated of June 8th, 1978, of the Labor Ministry.

A) SPECIALIZED SERVICE ON SAFETY ENGINEERING AND LABOR MEDICINE (SESMT)

The construction site will be provided with a SESMT, registered at the DRT, under the disposals of NR-4 standard. The service will be designed in accordance with the personnel mobilization plan and to the execution steps of the contract.

Both the Safety and Medicine services will be designed in accordance with Table II of NR-4, risk level 4. Both calculations will take in account the contractors' personnel.

B) HEALTH AND SAFETY PROGRAMS

The following programs will be implemented in compliance with the legislation:

b.1) Program of Environmental Risks Prevention (PPRA), according to NR-9;
b.2) Program on Work Conditions and Environment in the Construction Industry (PCMAT), according to NR-18, item 18.3;
b.3) Program on Medical Control of Occupational Health (PCMSO), according to NR-7.

The planning of personnel health actions will take in account local endemic diseases, such as, leishmaniasis, schistosomiasis, Chagas' disease, yellow fever, cholera and accidents involving venomous animals, among others, in compliance with the Public Health Agency of the region. A aid and antivenin medication application plan will be informed to the workers, specifically addressed to accidents involving venomous animals.

Only properly inoculated workers will be allowed at the working areas. The inoculation must be proved by proper documentation provided by the public health service. Any employee contracted or transferred from another site must be properly inoculated before starting their activities.

All registers of admission, periodic or dismissal examinations, as well as tends to injured workers, will be kept at the SESMT of the Construction Site and filed for at least 20 (twenty) years (NR-7, item 7.4.5.1).

The site will count on a program for controlling disease inducing vectors, to be followed during the works, which will comprise both preventive (screens, drainage of pooled water, disposal of wastes) and corrective (rats, bugs extermination, etc) measures.

C) STATISTIC REPORTS

A monthly statistic on accidents and a daily statistic on medical tends will be provided, comprising morbidity rates of the workers and the medical procedures taken at the site. In case of accidents, a Labor Accident Form (Annex I of NR-18) must be obligatory filled up.

D) REMOVAL PLAN

The construction site will count on a Removal and Care Plan for Injured Workers, defining the training and qualification required for the first aid personnel, the available material for tending to injured workers, the available communication system and its alternatives, the vehicles to be used (private, contracted or provided by the public service), the removal routes and the list of reference health institutions.

E) INTERNAL COMMITTEE FOR ACCIDENTS' PREVENTION (CIPA)

The CIPA must be assigned as soon as the implementation works start, according to the valid legislation. In addition to codes, activities and routine procedures of this Committee, the Maps of Environmental Risks will be also prepared, as a priority activity, and displayed, according to NR-5.

F) INDIVIDUAL AND COLLECTIVE PROTECTION DEVICES (EPI'S AND EPC'S)

The EPI's will be defined for each type of activity, based on the aforementioned Map of Environmental Risks, if these risks cannot be eliminated by proper measures. After this, an indicative spreadsheet of EPI's will be prepared, comprising usual and special EPI's to be used by the personnel of different functions. The EPI's must be provided, controlled and obligatory used according to NR-6.

The EPI's must be obligatory worn during the development of every activity. Special emphasis will be given to the proper utilization of electrical grounding, safety belts, helms, gloves and boots. The working areas will be signaled, warning the obligatory need for the utilization of EPI's the specific devices required for the areas.

Every employee will freely receive two working uniforms, stamped with the logo of the company. Whenever damaged, these clothes will be freely replaced, according to item 18.37.3 of NR-18.

Collective protection devices will be provided as required.

5.6.4.3 Transportation

All vehicles utilized in the construction site, private, freight or contracted ones, will be clearly identified as part of the construction site or as a service provider of the construction activities, by means of a painted signal or a sticker.

The vehicles will be driven by skilled drivers, who must obligatory carry their licenses, the vehicle documentation and, when driving outside the site limits, and authorization of the company for driving the vehicle and an authorization of the associated transportation official (Detran, etc.) for using the vehicle for transportation purposes.

The vehicles used for transporting workers must be properly adjusted for this purpose by the addition of fittings that provide the minimum safety conditions to the transported personnel. The vehicle must present a licensed load capacity compatible with the number of people or materials to be transported.

5.6.5 DEMOBILIZATION OF THE CONSTRUCTION SITE

5.6.5.1 Releasing the area

At the end of the construction works, the construction site must be reintegrated to the local scenery, with no damages to the environment or adjacent communities. At the end of the works, all buildings and structures must be demolished or disassembled and the area must be cleared by the removal of all materials and rubbish. The local drainage must be readjusted to the new conditions, in order to prevent pools or erosion processes at any point of the area or of external disposal areas.

5.6.5.2 Manpower Demobilization

The following procedures must be taken close to the end of the construction works, addressing to the personnel dismissal.

A) INFORMATION TO THE COMMUNITY

At least 30 days before starting the manpower demobilization, an information flow should start, addressed to the community, so the dismissal process can be performed free of conflicts with the community. Thus, the following aspects must be informed to those communities, as they comprise important expectation of them: financial commitments assumed by the employees, service providing contracts that will be dismissed, damages caused by the company and which need to be repaired, etc.

The information must be provided through the available communication media (broadcasting, loudspeakers, newspapers, public speeches, direct contacts of the construction management with the stakeholders, etc.), preventing those

information to be provided directly from the employees, generating rumors, distorted information and misunderstandings.

B) DISMISSAL EXAMINATIONS

The dismissal examinations must be performed in accordance with NR-7. For those areas identified as risky regarding endemic diseases, specific examinations must be provided to the related workers, in order to ensure that they were not infected by working at those areas.

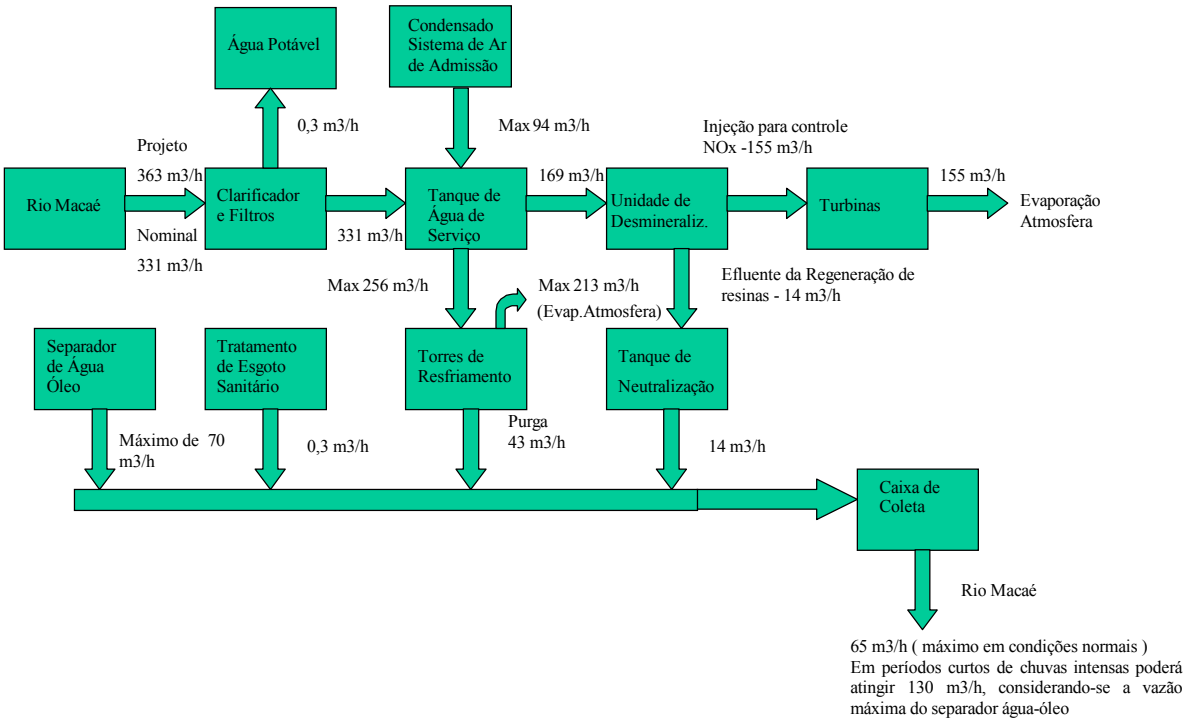
C) GUIDANCE TO WORKERS

The dismissed workers must be guided regarding their survival until finding a new job. If possible, they must be informed as for the likelihood of being re-contracted later for other construction works, including an estimate of the how long the unemployment period will last. No false expectations must be given regarding a new work, if it is not likely to occur.

5.7 LIQUID EFFLUENTS TREATMENT AND DISPOSAL

The water balance of the project, under he point of view of an environmental control, is displayed next, allowing a easy view of the water uses, intermediate streams and final streams of effluents of the units and treatment/control processes.

Simplified Water Balance - Macaé Merchant TPP



Água Potável = Potable Water
Condensado do sistema de ar de admissão = condensate from the air intake system
Injeção para control de NOx = Injection for NOx abatement
Rio Macaé = Macaé river
Projeto = Design
Nominal = rated
Clarificador e filtros = clarifier and filters
Tanque de água de serviço = service water tank
Unidade de Desmineraliz. = Demineralization Unit
Turbinas = Turbines
Evap. Atmosfera = Evap. To the Atmosphere
Efluente da Regeneração de Resinas = Effluents from the Regeneration of Resins
Separador Água-Óleo = Water-Oil Separator

Tratamento de Esgoto Sanitário = Sanitary Sewerage treatment
Torres de Resfriamento = Cooling Towers
Tanque de Neutralização = Neutralization Tank
Purga = Blow down
Caixa de Coleta = Collection Box
65 m3/h..... = (maximum, under normal conditions. For short downpours, it can reach 130 m3/h, considering the maximum flow rate of the water-oil separator)

The system will be composed by 4 sub-systems:

- Water-oil separation and treatment
- Blow-down of the cooling tower
- Neutralization of the effluents from the resins' regeneration
- sewerage treatment

The steams from all 4 systems will be routed to a collection box and monitored before the disposal into Macaé river, whose minimum net flow ($Q_{7,10}$) at the disposal area (where the river crosses under BR-101 road, downstream CEDAE and Petrobras water intakes) is presently estimated as 4,2 m^3/s, according to the hydrological considerations presented in item 5.7.5.

5.7.1 WATER – OIL SEPARATION

The stormwater from some areas of the plant will present variable oil contents, during rainy periods or in case of accidents. The stormwater drained from these areas is sent to a water-oil separator, which will collect the water from the following areas:

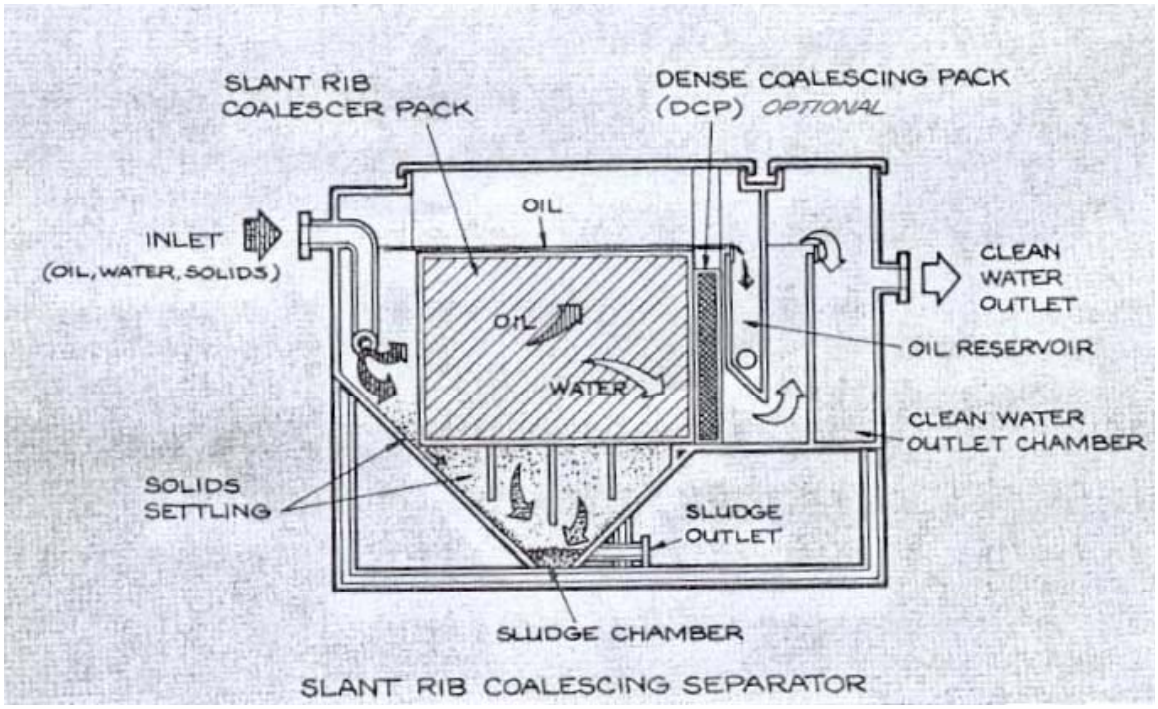
- Turbines' Room
- Generators' Room
- Lube oil skids
- Transformers' containment basins
- Maintenance area

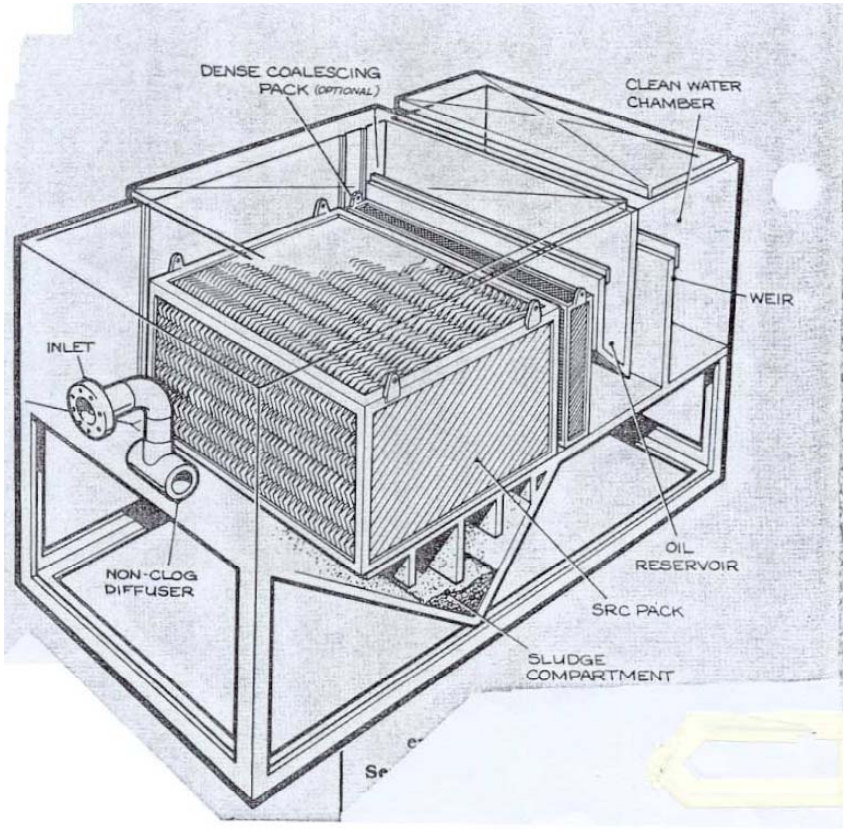
The drainages of these areas will be routed to the separator, designed for a total capacity of 70 m^3/h. Data on maximum rainfalls were obtained at the station 2241002 of ANEEL, in Macaé. The outlet stream of the separator will be also sent to a filter that will absorb remaining traces of oil that could still be present in the water stream. The water streams that leaves this filter will be then sent to the collection box before its final disposal into Macaé river.

The designed system, presented in the next Figures, is designed for a maximum outlet content of oil in the water of 10 mg/l of mineral oil, which complies with the limits recommended by the Wold Bank and represents half of the limit established by CONAMA and FEEMA (20 mg/l). The model of the equipment selected for the project is a SRC-300.

The separated oil and the oil dregs will be removed and sent for recycling by companies licensed by FEEMA for performing these activities.

Figure 5.7-1 – Water-Oil Separator





5.7.2 BLOW DOWN OF THE COOLING TOWER

The water in the cooling towers will be treated for controlling pH, preventing scaling/corrosion and the proliferation of algae, as required by the process. The pH adjustment will be performed by the addition of sulfuric acid, which will provide the required acidity while preventing the precipitation of dissolved solids. The scaling control is performed by phosphate-based agents, while the algae proliferation is prevented by biocides (such as sodium hypochlorite) as described in item 5.4.4. These chemicals will be used at low concentration (ppm) generating small concentrations of pollutants in the blow down stream of the tower. The blow down is required by the cooling process for reducing the concentration of dissolved solids that builds up during the six operational cycles of the system. The disposal of the blow-down will be performed considering the waster quality of Macaé river, in order to no compromise the present quality of its water. The cares taken before the final disposal of the effluent will take in account the temperature and the concentration of soluble substances previously existing in Macaé river at significant concentrations, such as phosphate and ammonia, as detailed in item 5.7.5..

During the cooling operation, the drain of the tower will be closed for certain periods, after the addition of the chlorinated biocide, in order to minimize the levels of residual chlorine and chlorides in the effluent generated by the tower blow down, which will then be sent to the collection box before the disposal into the river.

As an example of the effective impact of this effluent, the potential thermal impact of the tower blow down can be considered here. The temperature of this stream, under extreme conditions, could reach 38 ^{o}C. Considering the low temperature of the water of Macaé river, such as 15 ^{o}C, and comparing its minimum flow rate ($Q_{7,10=}$4200 l/s = 15120 m3/h) to the blow-down stream (43 m^3/h), the changes on Macaé river temperature would be practically neglectable (close to 0,16 ^{o}C) and compatible with the gradient established at the Previous License of the project (Δ<2 ^{o}C), complying with state and federal Brazilian regulations, as well as with international standards (Δ<3 ^{o}C). Item 5.7.5. presents a more detailed analysis of this aspect, consolidating the impacts of the effluents of the plant comparing them to the applicable b Brazilian legislation and to the figures recommended by the World Bank.

5.1.3 NEUTRALIZATION OF THE EFFLUENTS FROM THE REGENERATION OF RESINS

As seen before, the demineralization plant will be required for producing the water to the used in the NOx-abatement system of the turbines, as described in the EIA/RIMA. The demineralization process makes use of cationic and anionic resins in order to ensure extremely low contents of dissolved solids in

the water, compatible with the required uses. The demineralization process includes an unit for regenerating the resins, where acid and alkaline substances are used to wash the resins, recovering the ionic-exchange characteristics of them. The regeneration process is repeated until the depletion of the resins, when they become Class I solid wastes, as classified by Res. CONAMA 06/88 and associated federal and state regulations, requiring controlled handling, storage and final destination, as dealt in specific item.

Therefore, the regeneration of the resins generates and effluent that requires a neutralization before its disposal, which is performed by a pH adjustment by means of the addition of Sulfuric Acid or Caustic Soda. The final effluents must present a pH value close to 7 and contents of dissolved solids higher than the raw water, yet compatible with the maximum allowed and recommended values, as presented in item 5.7.5.

5.1.4 SEWERAGE SYSTEM

This project is presented at Item 5.3 of this PBA.

5.1.5 ASSESSMENT OF IMPACTS ON THE RECEIVING WATER BODY AT THE CRITICAL SCENARIO

Hydrologic Study

Macaé Merchant TPP will be located at the right bank of Macaé river, close to BR-101 bridge over the river, as displayed in the schematic map presented ahead, which also indicates the station MC-02 of FEEMA, which monitors the water quality, and the existing fluviometric stations. Macaé river, with a total length of 136 km and a total drainage area of 1.765 km^2, starts in Nova Friburgo, in the region known as Macaé de Cima, and crosses the municipalities of Casimiro de Abreu, Rio das Ostras, Conceição de Macabu, and Carpebus, with a drainage area of 949 km^2 close to the discharge point, located 15 km far from the river mouth.

The analyzed studies provide both qualitative and quantitative support to the assessment of the environmental impacts related to the disposal of effluents from Macaé Project.

The disposal area is located close and upstream the deactivated Severina station of the former DNOS. The drainage area (A) in this point is 949 km^2.

Basis of hydrologic information

The following studies were used:

- Study on minimum flow rates of the main water streams of Rio de Janeiro state, FEEMA.1978
- Support to the management of water resources of the hydrographic basins of rivers Macacu, São João, Macaé and Macabu. Projeto Planagua SEMADS/ GTZ.1999.
- Studies on the availability of flow rates of rivers Macaé São Pedro and Macabu. LIGHT/ HICON.2000.

SEMADS study (1999) is comprehensive and covers areas that interest water resources management and environmental studies, detailing mean and minimum potentials of the considered river. For Macaé river, the study is supported by studies of FEEMA (1978) which evaluated the minimum flow rates of the river.

LIGHT/ HICON (2000) study is addressed to Macaé river (São Pedro and Macabu) assessing the different water uses (present and future), focusing the daily and annual minimum streamflows with a recurrence of 100 years.

The stations listed in the Inventory of Fluviometric Stations (DNAEE / ANEEL) in Macaé river are :

Table 5.7-1 –Inventory of Fluviometric Stations in MACAÉ river /RJ

Code	Name	Operator	Lat.			Long.			Area (A,km^2)	Start	End	Type
150100000	Res. de Macaé	DNOS	22	22	00	41	47	00	1710	09/73	05/80	F D
150000000	Macaé	DNOS	22	22	00	41	47	00	1710	08/35	12/61	F
59146000	Ibiriri	DNOS	22	19	00	41	48	00	1481	06/52	07/56	F D
59145000	Faz. Pau Ferro	DNOS	22	17	00	41	50	00	1391	09/73	05/80	F R D
59139000	Severina	DNOS	22	18	00	41	53	00	896	09/73	05/80	F D
59137100	Pte. do Baião	DNOS	22	23	00	42	05	00	604	09/73	05/80	F R D
59137000	Pte. do Baião	DNOS	22	23	00	42	05	00	604	06/36	11/39	F
59175000	Piler	DNAEE/ANEEL	22	24	21	42	20	18	75	08/50		F D
59125000	Galdinópolis	DNAEE/ANEEL	22	22	09	42	22	46	101	08/50		F D Q
59120000	Macaé de Cima	DNAEE/ANEEL	22	22	22	42	27	44	66	05/67		F D Q

F: Provided with river gage.
D: Provided with net streamflow measurement.
R: Provided with limnigraph.
Q: Water quality station

No information is presently available from the stations operated by the former DNOS. The inventoried data were used for checking/validating the results of available studies.

It must be informed that LIGHT/HICON study made use of the stations located in the adjacent basins of Macacu and São João, using a regionalization-based methodology.

FEEMA study considers annual minimum flow rates and mean daily flow rates for 1,7,14 and 30 consecutive days and recurrence periods of 2,5,10,20,50 and 100 years. After selecting a Log-Pearson Type III distribution, the following data were obtained for Galdinópolis and Severina stations for the

selected recurrence periods (10 and 100 years) and duration values of 1,7 and 30 days.

a) Station: Galdinópolis

- River: Macaé
- Drainage area: A= 101 km^2
- Observation period: 1950 - 1975 (25 years)

Table 5.7-2 – Galdinópolis Station

Recurrence Period (years)	d= 1 day		d=7 days		d=30 days	
	Q1 m^3/s	q1 $l/s.km^2$	Q7 m^3/s	q7 $l/s.km^2$	Q30 m^3/s	q30 $l/s.km^2$
10	0,95	9,22	1,00	9,71	1,11	10,8
100	0,67	6,50	0,67	6,50	0,75	7,28

d= duration considered in the calculation.

Considering the flow rates for dry periods, the means for 1,7 and 30 consecutive days were calculated for Galdinópolis and Severina, followed by the definition of graphic correspondences between both stations for the observation period of Severina (10/73 through 03/75). Based on that algorithm, minimum flow rates were calculated, corresponding to Severina station.

b) Station: Severina

- River: Macaé
- Drainage Area : A= 939 km^2
- Observation period: 1950 - 1975 (values obtained by a correspondence to Galdinópolis)

Table 5.7-3 –Severina Station

Recurrence Period (years)	d= 1 day		d=7 days		d=30 days	
	Q1 m^3/s	q1 $l/s.km^2$	Q7 m^3/s	q7 $l/s.km^2$	Q30 m^3/s	q30 $l/s.km^2$
10	3,85	4,10	5,30	5,64	5,40	5,75
100	2,07	2,20	4,20	4,47	4,30	4,58

The integrated analysis of FEEMA results and available data took to the following conclusions:

a) FEEMA results are significant and represent consistently the actual conditions.

b) The regional analysis allow to assume the following general expression for minimum flow rates:

$Q_{d,T} = a\ A^{b}$

$Q_{d,T}$: minimum flow rate for "d" days and a recurrence period "T"(m^3/s)
a,b: empirical parameters
A : basin area (km^2)

Based on the preceding conclusions and on the flow rates measured at Galdinópolis and Severina stations, we have:

$Q_{7;10} = 31,6\ .\ A^{0,748}$
$Q_{1;100} = 64,9\ .\ A^{0.506}$

Thus, for the area at the disposal point of the plant (A= 949 km^2) we have:

$Q_{7;10}$= 5,3 m^3/s
$Q_{1;100}$= 2,1 m^3/s

It can be observed that these values are identical to those obtained for Severina station, since there are no expressive difference between the drainage area of that station (939 km^2) and the area corresponding to the TPP (949km^2).

Anyway, the regionalized expressions will support the evaluations for any other point of Macaé river course.

For LIGHT/HICON study, which used a regionalizing methodology, stations of Macacu and São João river were used, which are located in adjacent basins. The period used for this study was 1973 - 1999 (26 years).

In a general way, the studies performed by LIGHT/HICON are internally consistent and present results compatible with those obtained by FEEMA and analyzed above.

For assessing the environmental impacts of the disposal of the effluents from the plant, considering the dry season and minimum flow rates, the $Q_{7,10}$, can be conservatively used, since minimum mean values for less than 7 consecutive days and recurrence periods of 50 or 100 years will most unlikely occur during the lifetime of the plant.

Since there is no significant differences between the figures of both considered studies, the basic reference to be used here will be the minimum mean flow rate for 5 days and a recurrence period of 10 years, i.e. 5,3 m^3/s, as calculated by FEEMA. It must be observed that the historic flow rate of Macaé river at the disposal point is close to 12 m^3/s, while the typical values for rainy periods reach over 100 m^3/s

Considering the present perspectives of the water intake in Macaé river, upstream the considered disposal area, performed by PETROBRAS, NF TPP and CEDAE, with concluded or ongoing granting process before SERLA[1], the effective flow rate to be considered for impact assessment purposes is 4,2 m^3/s

The main physical, chemical and biological characteristics of the water quality of the receiving water body before the plant implementation and operation are presented in the next Table, based on the information provided by the water quality monitoring station of FEEMA (MC-02), available for the period 1990-1996.

[1] The available information indicates: 600 l/s for CEDAE, 167 l/s for PETROBRAS and 300 l/s for NF TPP. Obviously, part of these flow rates will be returned directly to Macaé river or its basin, which was not considered in this analysis.

TABLE 5.7-4 - WATER QUALITY AT STATION MC-02 – MACAÉ RIVER
1990 - 1996

PARAMETERS	STANDARD RES. CONAMA 20/86 – Class 2	NUMBER OF DATA	MINIMUM VALUE	PERCENTILE 10%	PERCENTILE 90%	MAXIMUM VALUE
Sample Temperature - ^{o} 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
Dissolved Oxygen – mg/l	5	35	0,1	6,4	8,4	9
Total Filterable Residue– mg/l (total of dissolved solids)	500	2	40	46	94	100
Non-filterable Residue– mg/l (suspended solids)	NR	35	8	10	75	120
Lead – mg/l	0,03	32	0,002	<0,02	<0,02	0,02
Cyanide – 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 Phosphorus – mg/l	0,025	33	0,01	<0,036	<0,1	0,4
Phenol – 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
Nitrite – mg/l	10	11	0,001	0,002	0,02	0,02
Ammonia Nitrogen –mg/l	0,5	35	0,01	<0,01	0,066	0,3
Nitrogen Kjeldahl –mg/l	NR	32	0,15	0,255	0,8	3
BOD $_{5,20}$ – mg/l	5	35	2	<2,0	<5,28	60
Fecal coliforms	1.000 *	36	< 1	ND	ND	34

Source: FEEMA
ND – not determined
* Limit for primary contact leisure

As analyzed in item 5.4, the most important parameter regarding the assessment of the impacts related to the disposal of effluents by the plant is the phosphorus content, due to its presence in either raw and clarified water to be used in the six concentration cycles of the cooling circuit and also to its utilization in this circuit as an anti-scaling agent. The high contents of BOD in the samples listed above, as already explained also, are mainly caused by the disposal of untreated sewerage, considering that Macaé river basin, in the

targeted area, is dwelled by a population composed by approximately 50 thousand people located in its drainage area (close to 120 thousand in the 1765 km^2 basin in 1996).

Assessment of the Effective Impacts due to Relevant Pollutants

The raw water will be supplied to the plant from a intake and treatment system independent from the potable water supply of the region, as described in the EIA and previously in this document. Therefore, no conflicts are expected with alternative uses, since the plant will make use of a new supply system for industrial water, comprising an intake in Macaé river, downstream the main intakes addressed to domestic and industrial uses of the region.

As preciously considered, a maximum flow rate of 65 m^3/h of treated liquid effluents will be pumped and disposed into Macaé river by a pipelines to be specially constructed for this purpose and by means of an adequate disposal system, in order to ensure a minimum impact on both the bank and the river bed, providing the fast dispersion of the pollutants upstream the raw water intake.

The impacts assessment took in account the pollutant levels recommended by the World Bank at the "Pollution Prevention Handbook, 1997" (Chapter: "Thermal Power - Guidelines for New Plants"), the available information of the project and/or information provided by specialized Databases, considering the characteristics of the raw water and the proposed uses (basically cooling, demineralization and potable water for the employees).

The main characteristics of the effluents are presented in the next Table, which also allows the comparison between the plant effluents and the limits of concentrations and temperatures addressed to the disposal into any receiving water body as established by Resolution CONAMA nº 20/86, article 21; by NT – 202 R.10 of FEEMA and the limits recommended by the World Bank.

Table 5.7-5 - Characteristics of the Effluents (in mg/l except where indicated)

Parameter	Guaranteed disposal values	Art. 21 Res. CONAMA 20/86	FEEMA NT-202.R-10	World Bank
pH	5 - 9	5 – 9	5 – 9	6-9
Temperature	< 40 °C	< 40°C (Maximum increase at the end of the mixture zone: 3º C)	< 40 °C Maximum increase at the end of the mixture zone: 3º C)	
Settleable solids	< 1ml/l (Imhoff cone test, 1 hour)	< 1ml/l, (Imhoff cone test, 1 hour)	NR	NR
Dissolved/suspended solids	500/50	NR (see art 23)	NR	NR / 50
Oils and Greases	20	20	20	10
Copper	0.5	1.0	0.5	0,2
Soluble Iron	3,5	15	15	3,5
Zinc	1	5	1	2
Heavy metals – total	10	NR	NR	10
Nitrates	10	10	NR	NR
Sulfates	500	NR	NR	NR
Phenol C6H6OH	0.2	0.5	0.2	0,5
Phosphates (PO_4)*	6	NR	NR	6
COD	150	NR	150	250
BOD(5 days @ 20 °C)	15	NR	Reduction of 80 %, at least	50
Chlorides	750			
Total Residual Chlorine	0.2	0.2	0.2	0,2
Coliforms	400/100 ml	NR	Controlled via BOD	400/100 ml

NR – Not regulated

Note: The targeted parameters at the effluents stream were defined based on the properties of the raw water to be collected at Macaé river, on the treatment processes previously described and on the chemicals to be used for treating both raw and clarified water in the Plant, using the most strict limits among the following criteria: last recommendations of the World Bank on December, 1998 1998 (Pollution Abatement Handbook – Guidelines for New Thermal Power Plants and General Guidelines), Art 21, Res. CONAMA 20 or Art 23, Res. CONAMA 20 – the classification of the receiving body must not be changed, and NT.202 R.10, FEEMA.

NR – not regulated

* The most restricted case of disposal into confined water was not considered, according to NT 202 R.10, FEEMA-RJ, (3mg/l) to which the water intake at Macaé river will imply on a content of phosphates of 0,3 mg/l in the industrial water (considering that 0,1 mg/l of P was the valued exceeded only in 10% of the samples of FEEMA between 1990 and 1996, with a ratio PO_4 / P, of approximately 3:1)

The valid Brazilian regulation (Art. 21 of Res. CONAMA 20/86 and NT – 202 R10 of FEEMA/RJ) establish the maximum limits for pollutants to be disposed into any receiving body. At the same time, art. 23 of Res. CONAMA 20/86 demands that the effluents do not change the water quality of the receiving

body beyond the mixing zone. These regulations require an additional evaluation of the impacts effective of the targeted effluents on the receiving body, considering its quality before the plant operation and the minimum flow rate $Q_{7,10}$, in order to simulate a critical scenario and thus assess the issue under a conservative point of view.

In order to evaluate the influence of the effluents disposal on the river, the characteristics of the effluents were considered as presented in the previous Table, considering the limits for Classes 2 and 3 for impacts assessment purposes. It must be highlighted here that the available measurements for this stretch of Macaé river, also analyzed above, indicated some non-compliance with Class 2 parameters, according to Res. CONAMA 20. The water quality of the river is presently somehow compromised by sewerage and phosphorus-based nutrients, intensively used by a number of agricultural areas located within the drainage area. Also, although no significant contents of toxic heavy metals were detected, such as lead and mercury, the values for phenols and cyanides exceeded the limits for the analyzed period.

In order top assess the thermal impact, the minimum temperature of the receiving body was considered, 15 ^{o}C, which is very conservative when compared to the available measurements (minimum value of 19 ^{c}C between 1990 and 1996). This temperature is also low considering the normal standards of the targeted river; so it can be also considered conservative for impact assessment purposes. In order to maintain the conservative approach, pollutant loads higher than the expected ones were considered, applying the maximum concentrations of the Table presented before to the total flow rate of the effluents of the plant (treated effluents streams from the resins' regeneration, the cooling tower blow down stream and the oil-water separation stream).

The instantaneous dilution model applicable to the conditions that will prevail in the mixing zone allows to obtain a conservative estimate on the maximum effective impacts of the effluents disposal. The instantaneous dilution (Q_{efl} / $Q_{7,10liq}$), in this case and considering a conservative analysis, will follow a 1:232 ratio ($65_{m3/h}$/$15120_{m3/h}$), as used in the next Table.

Table 5.7-6 – Assessment of the impacts of the liquid effluents – Worst Scenario, Minimum net flow rate Q7,10 of Macaé river (4,2 m^3/s) an maximum flow rate of effluents (65 m^3/h) – main parameters
mg/l except where indicated

PARAMETERS	MAXIMUM VALUE ASSUMED FOR THE PLANT EFFLUENTS	IMPACTS ON MACAÉ RIVER – CHANGES ON pH AND TEMPERATURE AND DERIVED CONCENTRATIONS (DI)	LIMITS OF THE RECEIVING BODY - RES. CONAMA 20/86 STANDARDS CLASSES 2/3
pH	9	0,0388	6-9
Temperature variation	40	0,1724	< 3 °C
Settleable solids	1	0,0043	NR
Oils and Greases	10	0,0431	VA
BOD5, 20oC	15	0,0647	5/10
Residual Chlorine	0.2	0,0009	0,01/NR
Copper	0.5	0,0022	0,02/0,5
Chlorides	750	3,2328	250/250
Phenol	0.2	0,0009	0,001/NR
Manganese	1	0,0043	0,1/0,5
Soluble Iron (Fe^{2+})	3.5	0,0151	0,3/5
Nitrates	50	0,2155	10/10
Phosphates (total)	6 (or 2 as P)	0,0086	0,025/0,025
Fecal coliforms	400 MPN/100 ml	1,7241	200/200
Zinc	1	0,0043	0,18/5
COD	250	1,0776	NR/NR
Heavy metals (total)	10	0,0431	NR/NR
Total dissolved solids	1000	4,3103	500/500
Sulfates	500	2,1552	250/250

N.R – not regulated although the absence of floating solids and foams or undesirable substances that could concentrate into the sediments is established
V.A – virtually absent

It can be observed that, since the effluents' flow rate is low and the concentration of the considered pollutants area low, even for minimum flow rates, when the dispersion effect is weaker, the impacts are not significant and would not change the characteristics of the receiving body, even when it is considered a Class 2 water body. In addition to this, settling effects of solids and the natural degradation of some pollutants were not considered, and the contribution of the drainage basin downstream the disposal point was neglected, which would provide an additional dilution of the targeted pollutants.

Resolution CONAMA nº 20/86 establishes that the increase on the temperature of the receiving body must not exceed 3 ^{o}C, and the maximum increase calculated for the studies case was close to 0,17 ^{o} C, considering a flow rate of 4,2 m^3/s at a temperature of 15 ^{o}C for a disposal of effluents at 65 m^3/h and 38 ^{o}C .

Resolution CONAMA 20/86 does not define limits for the concentration of oil and greases in the receiving body, defining, though, that these substances must be virtually absent. A practical limit of 1 ppm can be considered as virtually absent. Therefore, it is demonstrated that the immediate concentration of this parameter in the water will continue considerably low after the effluents disposal, considering a disposal concentration of 10 mg/l.

|After dilution, the concentrations of residual chlorine, soluble iron and zinc, in the receiving body, will continue below the maximum limits established by the standards, always considering the minimum flow rate, as presented in the previous table. The background contents of these substances are sufficiently low, anyway.

It is also observed that the maximum pH of the effluent – 9 – will take to a practically neglectable effect on the water, while the net contribution of the parameter total phosphorus for an instantaneous dilution - 0,008 mg/l as total P – lies bellow the legal limit for Class 2 rivers, representing an insignificant fraction of the maximum levels measured by FEEMA for this stretch of the river (up to 0,4 mg/l). Also, for soluble iron, it can be observed that the plant contribution, even when added to the present levels, does not represent any concerns.

Even for the worst simulated scenario, making use of a minimum mean flow rate for 7 days, which could occur only every 10 years, it can be seen that the expected impact will be absolutely acceptable, since the concentrations derived from the instantaneous dilution of the substances lie below the legal limits and do not comprise acute toxic substances or pollutants related to hazardous synergetic or bio-accumulative effects. Therefore, even the worst scenario comprises a neglectable impact under physical, chemical or biological points of view and there is no possibility of changing the class of this water body – even if it is reclassified as a Class 2 river – by the disposal of the liquid effluents of the plant, despite the conservative hypothesis assumed here.

Therefore, it can be concluded here that the impacts due to the disposal of the plant effluents are practically null, even for a Class 2 water body. If the present mean flow rate of Macaé river at the disposal point is considered, close to 12 m^3/s, the maximum concentrations of the pollutants would be three times lower than the values as calculated above.

5.8 LANDSCAPING PROJECT- MACAÉ-MERCHANT TPP

5.8.1 INTRODUCTION

According to the EIA, this project is part of the Mitigation Measures to be implemented during the Implementation step of the plant.

In addition to landscaping internal and external circulation areas of the plant, this project also includes the implementation of arboreous areas close to the fences of the plant, the formation of arboreous areas in the lands located in the surrounding areas of the plant in plain and undulated areas, as well as the thickening of the riparian vegetation in part of the margins of the old riverbed of Macaé river, that borders the plant at N-NE.

Native arboreous species will be utilized in order to harmonize the buildings to the surrounding scenery while also playing the role of physical barriers against winds and establishing an additional acoustic protection. The thickening of the existing riparian vegetation and the implementation or arboreous areas close to the plant can be started simultaneously to the plant construction..

5.8.2 COVERING

The landscaping project will comprise almost all clear areas of the plant, access ways, circulation ways and sidewalks around the buildings. Arboreous species will be planted along the fences, as well as along the right margin of the old bed of Macaé river, which comprises approximately a 1,200 m long, 20 m wide land strip, or 2.4 ha of rough agricultural land whose vegetation will be thickened. In addition to these areas, arboreous areas will be implemented in all building-free areas of the land.

The arboreous vegetation along the fences will comprise an approximate area of 4,0ha. In addition to these areas, 72,9ha of arboreous areas will be also implemented, comprising 47,0 ha in plain areas (18,0ha to be filled and the remaining 29,0ha in areas below elevation 5m) and 25,9ha in undulated areas.

The grassy areas will comprise 3,0ha , including cut and fill slopes.

The areas corresponding to the main access way (1,120 m) and to the internal circulation areas of the plant that are estimated in 8.000 m^2 (10% of the gross industrial area)

The Drawing annexed at the end of this Section displays the proposed landscaping. It must be highlighted that an area of about 4.5 ha will not be landscaped, since it is located under the existing transmission line.

5.8.3 METHODOLOGY

According to the different characteristics of the areas to be landscaped, comprising internal areas (access ways, parking areas and the areas surrounding the buildings), the thickening of the existing riparian vegetation, the implementation of arboreous areas and the implementation or arboreous species along the fences, the working methods will be described here in separate.

Nevertheless, the general edaphic and climatic conditions of the area as a whole were used as the basis of the conception of the landscaping project.

According to the environmental diagnosis of the influence area presented at the EIA-RIMA, the annual mean temperature is 23,5 ºC, varying from 19,7 ºC in the coldest month (July) through 39,6 ºC in the hottest one (January). The lower temperatures and rainfalls occur between May and September, while the higher temperatures and rainfalls occur between November and April, comprising the most favorable period for the vegetation development. The annual mean rainfalls can reach up to 1.177,6 mm, depending on the prevailing climatic factor along the year, but usually concentrated between November and January. the annual mean air humidity oscillated around 80% with no significant variations along the year.

The rainy season usually comprises most of the annual rainfalls, starting in September/October and lasting until march/April. From November to April, the rainfall indexes exceed the total monthly evaporation rates, while between may and October, the situation is the opposite, indicating the need for hydric supplementation for the planted areas during this period, especially during the first two or three years of revegetation, due to the insufficient humidity of the soils. These consideration are especially important in the case of the arboreous species, since the lining shrubby/herbaceous ones and the species planted in vases should be normally irrigated all year round.

According to available data, the prevailing winds direction is N-NE, from January to October, with average velocities ranging from 9,3 km/h (March to July) to 14,8 km/h (August).

Regarding the soils, the undulated areas, where the plant and the substation will be implemented, are composed by Red-Yellowish Latosols, non-hydromorphic mineral soils with clayish texture, deep to very deep, well drained, predominantly caulinitic, strongly acid, with low cation exchange capacity and high content of free alumina. The plain areas are composed by less evolved, gley soils, with drainage problems, not deep and with low natural fertility levels. Part of these areas will be filled by latosols removed from the area where the plant will be constructed, such as the area located to the left of the main entrance; other areas, such as the one located between the bottom of the slope and the boundaries of the site, below elevation 5m, will be revegetated with species adjusted to these drainage conditions.

A quick field survey revealed the general characteristics of the lands where the different species will be planted. These informations were completed by existing studies and surveys addressed to the fertility of these areas. Based on these data, it was possible to properly define the fertilization and acidity adjustment methods to be implemented for these areas, recommending soil conservation procedures to be taken, especially for the undulated lands, close to cuts.

5.8.4 General Characteristics of the Areas or Project Areas and Description of the Activities

5.8.4.1 Main access ways, internal and external circulation ways

These areas comprise 1.120 m (main access way) and 8.000 m^2 of internal circulation ways, besides 30.000 m^2 of grass areas in slopes, according to the annexed drawing. These areas were designed in a topographic plan of the area (scale 1: 2.500), presented in the EIA/RIMA.

The landscaping project considered large palmaceous for the sidewalks of the main access, comprising a total length of 1.120m. The landscaping of the circulation areas around internal buildings, comprising a total area of 8.000m^2 and including the administration building and the parking lot, is based on a variety of ornamental species, both shrubby and herbaceous, completed by elements such as vases, flower stands and pebbles.

The ornamental herbaceous and arboreous species are listed in the next Table

Table 5.8-1: Some ornamental species to be used.

Application	Common name	Scientific Name
Vases and stands	Miscellaneous Bromélias	Bromeliaceae
	Cacto	*Cereus peruvianus* Cv. variegata
stands	Coroa-de-Cristo	*Euphorbia milu*
	Cinerária	*Sinescio douglasii*
	Trapoeraba roxa	*Tradescantia pallida* Cv. purpúrea
Stands and beds	Plumbago	*Plumbago capensis*
Beds	Alamanda	*Allamanda cathartica*
	Estremosa	*Lagerstroemia indica*
	Filodendro	*Philodendron sp.*
Beds and vases	Agave	*Agave americana*
Gardens	Areca bambu	*Chrisalidocarpus lutescens*
	Bougainville	*Bougainvillea spectabilis*
	Palmeira	*Diplothemium maritimum*
Recovering slopes	Margaridinha	*Wedelia paludosa*
	Grama Esmeralda	*Zoysia japonica*
Shrubby fence	Pingo-de-ouro	*Duranta repens va. Aurea*
	Hibiscos híbridos	*Hibiscus rosa-sinensis*

According to the characteristics of the area, aspects such as insolation level, exposure to winds and others are very important in order to define the species to be used.

the main access will be planted with large palmaceous, such as *Arecastrum romanzofianum*, planted at a distance of 4.0 m from each other. Another specie that can be used for lining the accesses is the palm tree (*Euterpe edulis*). Narrower internal ways, as well as the parking area, should preferably use species such as *Bauhinia forficata*, and *Caesalpina ferrea*, which are very beautiful species, with sub-rounded crowns that provide large shadow areas and with fruits that cannot damage vehicles parked underneath them. In addition to these aspects, these species present taproots and persistent leaves.

All cut and fill slopes must be recovered with grass or, alternatively, with *Vedelia paludosa*, which is satisfactorily adjustable to this type of land in a short term. Although these practices are essential to the erosion control, the revegetation of the areas that surrounds these slopes with arboreous species is also fundamental for interrupting any existing erosion process pr preventing new ones.

The agronomic practices to be taken for implementing these areas are summarized next:

- Pre-planting:

– Acquisition and acclimation of the cuttings: one month before planting, the acquired cuttings must go through an acclimation process in the area.

– Preparation of the areas: this step will comprise clearing the land to be planted; localization, opening and addition of dolomitic limestone (500g), super-phosphate (400g) and potassium chloride (300g) in the pits (0,40m x 0,40m x 0,40m) for the arboreous species and half of this dosage for the shrubby ones; preparation of the substrate for the beds, stands and vases (three parts of local soil and one part of organic matter over a base of draining material equivalent to 10% of the volume – crushed rock).

- Planting activities:

– Right after planting, all areas (shrubby and arboreous pits, stands, bed and vases) should be irrigated, expect for the grassy areas, where the land should be previously irrigated and receive organic manure. After these operations, the planting can be really started.

The arboreous species must be between 1,50 and 2,0m high, free of pests and diseases. After planted, theirs cuttings must be supported by hard wooden laths (2,50m x 0,05m x 0,02m) and protected by a cylindrical metallic screen structure until at least 4 years after planted. The traditional pits must be replaced by two pre-molded concrete rings (1.2 m of diameter, 0.5 m high and 0.05 m thick) when the cuttings are planted close to buildings; in order to avoid damages to these structures caused by the roots.

- Maintenance activities:

– Irrigation, re-planting, pruning, phytosanitary treatment as required, i.e., according to regular inspections for controlling the action of ants and other pests, crowning of shrubby and arboreous cuttings every 30 days, clearing the lawns every 30 days, clearing beds, stands and vases every 15 days, supporting fertilization (using phosphate-potassium fertilizers for the shrubby and arboreous species taking in account the planting dosage divided in two portions/year and nitrogen-based fertilizer for the ornamental ones, 30, 60, 120 and 180 days after planting, at a ratio of 40g of ammonium sulfate for each plant and proportional ratios for vases, beds and stands). After this period, these practices must be repeated every 3 months, keeping the same dosages.

5.8.4.2 Thickening of part of the riparian vegetation of the marginal protection area of the old bed of Macaé river, reforestation of plain, poor drained areas and undulated, well drained areas and implementation of arboreous vegetation along the fences

These areas were also designed over the topographic plan of the area, referenced by the general layout of the project.

The thickening of the riparian vegetation of Macaé river intends to protect this area against potential pollutant effects, while complying with the Forest Code for this type of land. The area comprises 24,000 m^2 (1.200m long x 20 m wide – average). These areas will be plowed toward the site (firebreaks).

In order to prevent as much as possible any interventions in the area after planting it, dense vegetation spots were considered, avoiding as much as possible replanting activities. The cuttings should be 0,50 -1,50 m high, with a minimum lower diameter of 2,0 cm, free of pests and diseases. Replanting activities will be only performed in case of fire, pests or diseases that could drastically reduce the original quantity of plants.

Since the present vegetation of the area is composed by exotic, invaders gramineous species and reminders of the natural riparian vegetation no machines are recommended, so a manual thickening is indicated. Firebreaks (5.0 m wide) should be made in the area, separating the thickened marginal protection area of its vicinities and allowing the circulation through the areas for inspections and treatments.

The arboreous native species to the used in the marginal area of Macaé river and in undulated areas are listed next.

Table 5.8-2: Species to be used for revegetating part of Macaé river margin and undulated and plain areas.

Common name	Scientific name	Ecological group (*)
Açoita-cavalo	*Luehea divarigata*	NP
Aleluia	*Senna multijuga*	P
Anani	*Symphonia globolifera (TE)*	NP
Angelim amargoso	*Andira anthelmia*	NP
Angelim rosa	*Andira fraxinifolia*	NP
Angico vermelho	*Anadenanthera macrocarpa*	P
Araribá	*Centrolobium tomentosum*	NP
Aroeira	*Schinus terebinthifolius*	NP
Bacupari	*Rheedia gardneriana (TE)*	NP
Bainha-de-espada ou Fura-olho	*Sorocea hillanii*	NP
Braúna-preta	*Melanoxylon brauna*	NP
Canela ferrugem	*Nectandra rigida*	NP
Canjerana	*Cabralea canjerana*	P
Carrapeta	*Guarea guidonia*	NP
Caxeta	*Tabebuia cassinoides*	P
Cedro-rosa	*Cedrela fissilis*	NP
Crindiúva	*Trema micrantha*	P
Cutieira	*Joanesia princeps*	NP
Dorstenia	*Dorstenia arofolia*	NP
Fedegoso	*Senna macranthera*	P
Figueira-do-brejo	*Ficus insipida*	NP
Guapuruvu	*Schyzolobium parahybum*	P
Imbaúba	*Cecropia hololeuca (TE)*	NP
Ingá	*Inga spp.*	P
Ipê rôxo	*Tabebuia heptaphylla*	P
Jacarandá do litoral	*Platymiscium floribundum*	P
Jacatirão	*Miconia cinammomifolia*	NP
Jenipapeiro	*Genipa americana (TE)*	P
Jequitibá-rosa	*Cariniana legalis*	NP
Maricá	*Mimosa bimucromata*	P
Marupá	*Simarouba amara (TE)*	P
Mulungu	*Erythrina velutina*	NP
Nó-de-cachorro	*Brosimum guianensis (sp.)*	NP
Oiticica	*Clarisia ilifolia (racemosa)*	NP
Olho-de-cabra	*Ormosia arborea*	P
Orelha-de-macaco	*Enterolobium contortisiliquum*	NP
Pata-de-boi, unha-de-vaca	*Bauhinia forficata*	P
Pau -Brasil	*Caesalpinia echinata*	P
Pau-ferro	*Caesalpinia ferrea var. Leiostachya*	P

Pau-jacaré	*Piptadenia gonoacantha*	P
Pau-viola	*Citharexylum myrianthum*	NP
Peito-de-pombo	*Tapirira guianensis*	P
Pindaíba vermelha	*Xylopia sericea*	P
Pindaíba-do-brejo	*Xylopia emarginata*	P
Quaresmeira	*Tibouchina granulosa*	P
Sabiá	*Mimosa caesalpinifolia*	P
Sangue-de dragão	*Croton urucurana (TE)*	NP
Simaruba	*Simarouba amara*	NP
Tabebuia-do-brejo	*Tabebuia umbellata (TE)*	NP
Tapiá	*Alchornga glandulosa (TE)*	NP
Vinhático	*Platymenia foliosa*	NP

(*) P – P – Pioneer; NP – Non-pioneer; TE – Tolerant to floods, adequate for poor drained areas.

Although these are species represent and indicate environmental conditions previous to the present ones, other species will slowly arise under these new conditions, enriching the revegetated areas.

The arboreous areas to be implemented on plain and undulated areas must be prepared in pits separated by firebreaks, following the land features, bordering the access ways to the secondary facilities of the plant and comprising a total area of 51,0ha. The implementation of these areas must be preferentially performed to SE-NW direction, perpendicular to the prevailing direction of the winds (N-NE), as indicated in the annexed Drawing.

The technical specifications and agronomic practices to be taken for implementing these areas are the same as those indicated for the revegetation of the marginal areas of Macaé river, adjusted in some points. The implementation of contour borders (0.40m x 0.50m-trenches addressed to collecting and routing surface waters) and the leveled planting are soil conservation practices recommended for undulated areas and fundamental for a successful revegetation as proposed here, since the help on interrupting ongoing erosion process or preventing new ones triggered by earthworks or other intervention on the soils of the area.

- **Pre-planting activities:**

- Acquisition and acclimation of the cuttings in a small lathwork to be done at the area;
- Delimitation of the area;
- Land clearing;
- Soil conservation measures for undulated areas;
- Localization, opening and preparation of pits; and
- Firebreaks.

Planting activities:

– Foundation fertilization simultaneous to planting (phosphate-based fertilizer + manure);
– Irrigation;
– Cuttings crown, and
– Phytosanitary treatment.

Maintenance activities:

– Replanting;
– Supporting fertilization (2 times);
– Phytosanitary treatment; and
– Crowning the cuttings every 30 days emphasizing the wet season of the first 3 or 4 years.

The revegetation of the areas along the fences and of free areas within the site (plain and undulated areas) is particularly important, not only for landscaping reasons but also for attracting birds and other animals, contributing to enrich the local biota, for representing physical barriers against winds and noises and mostly, by playing the role of barriers against existing erosion processes or by preventing new ones, especially at the slopes of cut and fill areas.

The land strips along the fences, presenting an approximate width of 10m, should be preferably revegetated with arboreous, nitrogen fixating leguminous species, so both their implementation and maintenance can be performed at low costs.

The perimeter of the south, north (beyond the transmission line) and west fences comprise approximately 4,000 m or 4,0 ha to be revegetated with arboreous species.

The distribution of these trees, when adults, must be as dense as possible so they can really play the role of a barrier against winds and noises as expected. Therefore, different sized species are considered in this project. Therefore, these areas will not only play the role of barriers against winds, but

will also act as an additional security feature of the plant. Fig 5.8-1 displays a scheme of the proposed configuration.

The leguminous species to be used in this case are presented next:

Table 5.8-3 – Proposed Leguminous Species

<table>
<tr><th colspan="3">Adult height (m)</th></tr>
<tr><th>5 to 10</th><th>10 to 20</th><th>More than 20</th></tr>
<tr><td rowspan="2">Mimosa caesalpiniaefolia (Sabiá)</td><td>Piptadenia gonoacantha (Pau Jacaré)</td><td rowspan="2">Enterolobium contortisiliquum (Orelha de negro)</td></tr>
<tr><td rowspan="2">Inga marginata (Ingá)</td></tr>
<tr><td>Mimosa bimucronata (Maricá)</td><td>Clitoria fairchildiana (Sombreiro)</td><td>Albizia saman (Albízia)</td></tr>
</table>

In order to work as an effective barrier against winds, the indicated species will be planted from 1.0m far from the fence. It is recommended a three line quincunx arrangement, the minor species in a 1,0m x 1,0m space distribution; two lines of intermediate sized species (2,0m x 2,0m) and two lines of major species (4,0m x 4,0m). Therefore, for planting an area of 2,0 ha, it will be necessary 3,000 cuttings of small species, 1.000 cuttings of intermediate ones and 500 of larger ones, which corresponds to a demand of 1750 cuttings/ha.

The agronomic practices to be taken for implementing these areas are basically the same described for thickening the riparian vegetation of Macaé river:

Pre-planting activities:

- Acquisition and acclimation of the cuttings in a small lathwork to be done at the area;
- Delimitation of the area;
- Land clearing;
- Application of limestone;
- Localization, opening and preparation of pits; and
- Firebreaks.

Planting activities:

- Foundation fertilization simultaneous to planting (phosphate-based fertilizer + manure);
- Irrigation; and
- Phytosanitary treatment.

Maintenance activities:

- Replanting;
- Supporting fertilization (2 times);
- Phytosanitary treatment; and
- Crowning the cuttings every 30 days during the wet season.

5.8.4.3 Special areas

These areas are located in the immediate vicinities of the industrial plant, most specifically close to the spring and the lake located to the south of the facilities, at the bottom of the slope. A major part of these areas is affected by an existing Transmission Line and by the line that will send the power generated by the plant to the Substation. Therefore, only a small stretch of the lake margin can be revegetated with arboreous vegetation, while the remaining areas cannot be landscaped for safety reasons, which do not allow planting arboreous species under transmission lines.

5.8.4.4 Timetable, quantities and costs

This project will be implemented during and after the construction works. A total period of 6 months is estimated as required for implementing and maintaining the initial arboreous revegetation – plain and undulated areas, the marginal area of the river and the fences – followed by another period of 6 months addressed to landscaping access and circulation ways and the areas around buildings and other industrial facilities.

The implementation of the arboreous vegetation at the margin of Macaé river and at the areas along the fences can be started simultaneously to the plant construction, while the landscaping of all other areas will be started right after before the completion of the plant construction.

The implementation of this landscaping project should be performed by a specialized professional that would oversight all required services, providing all necessary resources to be used. In this case, the plant should be responsible for managing these activities, directly or not, by contracting an autonomous professional or a supervising company.

Figure 5.8-1

5.9 DETAILED PROJECT OF THE NATURAL GAS DISTRIBUTION PIPELINE BRANCH

As previously mentioned in the beginning of this document, the Detailed Project of the Natural Gas Distribution Pipeline Branch will not be considered in this document, since it will be a responsible of CEG – Companhia de Distribuidora de Gás do Rio de Janeiro Ltda, and subsequently issued to FEEMA in order to get the respective Installation license.

5.10 TRANSMISSION LINES

The project of the Thermal Power Plant does not include specific transmission lines, but only an interconnection between the substation of the plant and the existing transmission lines of Furnas that cross the site.

5.10.1 CONCEPTION OF THE INTERCONNECTION PROJECT

5.10.1.1 Forewords

The interconnection between the Substation of Macaé TPP and the 345 kV Transmission Lines of FURNAS Centrais Elétricas SA will be performed by means of a Interconnection Substation which will basically comprise a switch substation with a one and a half circuit breaker configuration, two lines inlet and fours outlets. These lines' outlets will be interconnected to the 345 kV lines of FURNAS by four Interconnection Transmission Lines. The two existing Transmission Lines of FURNAS, which interconnect the Substations of Adrianópolis and Campos, will be sectioned by the insertion of a tower in each line and, subsequently, after the start up of Macaé TPP, theirs jumpers will be removed, when the lines will be sectioned.

After sectioned, FURNAS Transmission Lines will become two new lines, as follows: Adrianópolis-Macaé and Macaé-Campos, continuing through their interconnection to the bus bar if Macaé TPP Interconnection Substation.

5.10.1.2 Characteristics of the Transmission Lines

The basic characteristics of the Interconnection Transmission Lines are:

Rated voltage: 345 kV

Number of circuits: 4 (four)

Number of circuits per tower: 1 (one)

Arrangement of the conductors: horizontal

Number of conductors per phase: 2 (two)

Conductors' gauge: 954 MCM Rail code

Number of lighting wires per circuit: 2(two)

Number of towers/gantries per circuit (except for the SE gantry): 3 (three)

Grounding system: continuous counterweight wire, underground, depth: 0,8 m.

Width of the right-of-way area: 180 m for all 4 circuits (estimated)

Average length of the lines: 250 m

Basic Description of the Interconnection Lines

The Interconnection Lines will be connected to the gantries of the Interconnection Substation (SE) and their first towers/gantries will be located at approximately 18 m from the axis of the municipal road that accesses the plant. These towers/gantries will allow the angles required for the alignment of each circuit of the gantry to FURNAS Transmission Lines.

The interconnection between the Interconnection Lines and FURNAS Lines will be performed with horizontal spans at each side of the interconnection lines, mounted into gantries and allowing the interconnection between the conductors by flying taps. (See Drawing “Localização da Subestação e Conexão com LT´s 345 kV de FURNAS”)

Physical Characteristics

The Transmission Lines will be constructed with trellis-shaped supports (towers and/or gantries) of galvanized steel, with foundations designed and constructed on reinforced concrete blocks on solid ground and free of groundwater. The wires will be made of aluminum and steel (ACSR type) while the lightning arrester wires will be constructed of HS-type galvanized steel. The anchors will be provided with tempered glass and the hardware will be drawn-type and assembled as established by the detailed project.

The hardware of the lightning wires will be also drawn and assembled according to the detailed project.

The grounding wires will be designed by the detailed project and buried at a depth of 80 cm, interconnected to the structures by means of tightly interconnected tails.

Route and Right-of-Way

The route of the transmission lines crosses a dry area, covered only by pastures, not crossing creeks, rivers or roads, nor requiring any type of land clearing (deforestation). This area is presently degraded and altered by human activities, so the environmental interferences due to the route of the transmission lines will be minimal.

The Right-of-way is a setback area for safety purposes and must be free of obstacles, in order to prevent risks to both the transmission lines and human beings. This area (estimated in 30 ha) will be negotiated and defined by means of indemnifications, according to the Decree-Law nº 3.365 of

06.21.1941, Law nº 8.987 of 02.13.1995 and Law nº 9427 of 12.25.1996, this one issued by ANEEL.

5.10.1.3 Detailed Project, Supply, Construction and Assemblage

Detailed Project

The detailed project will be performed by the company responsible for the supply, construction and assemblage. The project will be presented to FURNAS, which, according to the present legislation (Resolution No. 433 of ANEEL) must analyze and approve the project, which will be then developed based on the specification and definitions of FURNAS, either regarding the Interconnection SE or the Interconnection Lines.

Supplies

All materials will be acquired in the national market by the Contractor and must be the best-quality ones. Their trademarks and manufacturers/vendors must be previously approved by the Owner, in strict compliance with the Technical Specifications of the Project;

5.10.1.4 Construction and Assemblage

Scope of the Services

The construction of the Interconnection Transmission Lines will basically comprise the following services:

a) Provisory facilities of the construction site;

b) Preparation of the foundations' project;

c) Construction and/or enhancement of the access ways;

d) Load, transportation, unload, storage and conservation of all materials, from their delivery to their utilization or return;

e) Topographic checking;

f) Execution of foundations;

g) Assemblage of towers and/or gantries;

h) Installation of counterweight, measurement of the soil resistivity, grounding of fences, etc.;

i) Installation of conductors, lightning wires and fittings;

j) Complete revision of all performed services;

k) Assistance to the final tests and commissioning;

l) Recovery and reconstruction of all interferences to the soil and environment, bringing them back to the existing conditions prior to the works ;

Organization

The Contractor will be responsible for organizing the construction site, which will basically comprise:

a) Providing the supervision and management of the services, manpower, transportation, tools, construction and assemblage equipment, testing instrumentation, general materials, consumption materials and other required items;

b) Organization chart of the works, down to the level of chiefs in charge, with different assignment for all different areas/functions;

Operation and Maintenance of the Construction Site

The construction, operation and maintenance of the construction site, lodging areas, cafeterias and other facilities required for the works of the Contractor, including water and power supply, sewerage, transportation of personnel, sentry, medical care, industrial safety and hygiene services, maintenance of storage areas and warehouses, workshops, kitchen, pantry and any other facilities required for the proper functioning of the site, will be a duty of the Contractor.

Procedures of the Construction Site

Procedures will be established for the operation of the construction site, including, but not limited to, the following ones, which will be reviewed as required:

a) Identification:

All vehicles must be clearly identified by the name of the Contractor placed at the windshield;

b) All personnel involved with the services of the site must permanently wear an identification card, including name, function, Contractors' name and a picture of the employee;

Fire Fighting and Protection

The Contractor will be responsible for the protection of all facilities of the construction site against fire, installing all required equipment and devices;

Industrial Safety and Hygiene

The disposals of the Document "Normas de Segurança e Higiene Industrial" (Standards for Industrial Safety and Hygiene), presented in Annex 1 at the end of this Section, will be strictly followed.

The workers must wear adequate shoes, approved helmets and clothes whenever working at the construction areas;

Communication media

The Contractor must provide, at its own expenses and before the adequate officials, the installation and operation of the required communication media.

Ownership of the Construction Site Facilities

All provisory facilities of the construction site will be owned by the Contractor and must be removed from the area at the end of the works. The areas must be left clean and clear, including the demolition of foundations. The area environment must be returned to the original conditions existing before the implementation of the construction site;

Quality Control

The Contractor is responsible for the quality of the provided services, which will be controlled by a specific team, previously approved and compatible with the nature and extent of the works, which must meet the following minimum requirements:

a) The Quality Control team will be independent of the production structure, reporting to the highest hierarchic level of the Contractor;
b) The team will be composed by technicians with a strong knowledge on the scope of the services, execution drawings, technical specifications and technical regulations applicable to the services;
c) The team will be provided with facilities and equipment adequate to the development of its tasks or it will hold

agreements with specialized technical organization, provenly qualified, in order to perform the required essays;

d) The Quality Control activities will be supervised by the Owner of the project or by a person assigned by them, whether by performing parallel essays or by performing audits in the implemented system;

Procedures with Materials

The materials belonging to the scope of the Contractor will be delivered in the Construction Site. After received, these materials will be handled, preserved and stored for further transportation to the installation areas, by and under the responsibility of the Contractor, which will keep a permanent logging of the aforementioned materials and will follow the procedures listed next:

a) Storage:

The materials of the towers will be stored in a dry area, on wood pallets and not in contact with the ground. The storage arrangement will be performed according to the type of the structure, in order to allow the proper loading-unloading operations of vehicles. Screws, nuts, etc. will be stored in a sheltered area, into wood boxes, in order to facilitate their separation and inventory.

The wheels of conductor wires and lightning wires will be stored on a drained, dry ground area. Their axis must be positioned in a horizontal arrangement and their protections must be removed only for unrolling them;

Isolators and hardware must be also stored in a dry area, not in contact with the ground and disposed in order to facilitate the stock control. The isolators will be treated with a maximum care, in order to prevent any damages.

b) Transportation

The transportation of all materials, as well as the return of surplus, must be coordinated with the field teams, preventing any shortage of materials in the site, also preventing that unused materials remain in the working areas, not meeting the required storage conditions:

The wire wheels will be transported with their axis in the horizontal position and disposed in the same way of the vehicle displacement. Loading and unloading operations will be obligatory performed by cranes, forklifts or other process that ensures the integrity of the wheels.

Special care will be taken during the transportation and handling of hardware, in order to prevent damages to their finishing.

Isolators and hardware can be only transported within original boxes or packages or within other adequate packages.

Working Methods

The services will be performed in compliance with pre-established criteria and, specially, in compliance with the criteria indicated at technical drawings and specifications. The working methods will be a free alternative of the Contractor. Special care must be taken in order to eliminate risk to third parties, as well as to employees that could take to unsafe or non-productive situations.

Services in Powered Areas

Services performed in or close to powered areas must be preceded of a special authorization issued by the responsible officials. The working areas must be isolated and special care will be taken regarding the utilization of tools and personal protection devices.

Site Logbook

A Logbook will be kept, composed of sequential, numbered sheets, with copy-sheets, for logging daily occurrences (summarized description of the performed works, received service orders, warnings, climatic conditions, paralyzed manpower and others). The sheets will be noted and signed by the authorized representatives of both parties on a daily basis.

Professional registration and Licenses

The Contractor is responsible for effect the licensing of the services before the Regional Council of Engineering, Architecture and Agronomy – CREA as well as to obtain the Construction License before the Municipal Administration .

Project Drawings and Documents

All contracted project documents will be provided to the Contractor, which will assess them in order to check the existence of errors por omissions that could restrain or difficult their work. In case of conflicts or omission in the project documents or in case of doubts related to their interpretation, the design company must be consulted for the proper explanations.

After the completion of each step of the works, the Contractor must forward to the Owner a complete set of all drawings, instructions and specifications with all notations related to all changes occasionally performed and previously

authorized, reproducing them in order to faithfully represent the executed services. If no changes were performed, the drawing must include the following notation: Executed Without Modifications.

Ownership of Projects and Drawings

Any drawings, specification or other documents provided to the Contractor will continue to be a property of the Owner and the Contractor is not allowed to make use of them for other purposes than those that motivated their supply.

Planning, Scheduling and Physical Control

The planning, scheduling and physical control of the services' development will be based on toe contract timetable and on the executive timetable.

A fortnightly scheduling of the services to be performed must be prepared, in order to mirror times, sequences and milestones in the executive timetable. This schedule will guide the works and will comprise:

a) Scheduled works for the fortnight period;
b) Predicted manpower;
c) Distribution of construction equipment;
d) Predicted production and consumption.

A physical-control system will be established for the works execution, in order to allow the follow-up of the works, identifying delays and allowing defining and dealing with problems within an adequate timeframe.

The quantities of services actually produced will be controlled and noted in order to allow their comparison to the respective fortnight predictions. The manpower will be also controlled, as well as the utilization of construction equipment, by means of a form to be monthly issued, containing:

Monthly manpower, withdraws, vacations, retainments and dismissals.

Number of worked hours, per equipment, including paralyzations and off-service hours.

Environmental Protection Measures

All valid regulations and laws will be met regarding environmental protection. All procedures addressed to prevent and minimize the negative impacts of the works on the environment will be taken. These procedures must comprise, but not be limited to, the following:

a) Land clearing and earthworks, when required, but be strictly restricted to the required areas. The local vegetation covering of all other areas will be preserved.

b) Defoliating chemicals will be strictly prohibited for land-clearing purposes.

c) The areas leveled for future of provisory utilization will be provided with an adequate drainage system, provisory or permanent, in order to prevent the restrainment of water and associated erosion processes.

d) After the utilization of the area is discontinued, the Contractor must provide its recomposition, bringing it back to the previous natural conditions, as feasible as possible.

e) The burning of rubbish and wastes will not be allowed. These materials will be stored in a specific area until their final disposal is provided.

f) The sewerage system must be carefully planned in order to prevent any contamination of water bodies or groundwater.

g) Vehicles and equipment used in the construction activities must be properly maintained in order to prevent excess of smoke, noise and leakages. Adequate procedures must be taken in order to minimize the emission of dust due to the traffic of vehicles throughout the construction site.

Brazilian Regulations

The described services, projects and supplies must comply with all guidelines and recommendations of the Brazilian Regulations, except when clearly stated differently. The regulations usually applicable to the aforementioned services are: NBR 5422, IEC 826/91, ASCE 52/86, NESC, ASTM, ISO, ANSI, IEEE, NEMA, AWS and AISI.

5.10.2 CONCEPTION OF THE STEP-UP SUBSTATION PROJECT

5.10.2.1 Forewords

The interconnection between Macaé TPP and the National Transmission System (Basic Network) will be performed by means of a Step-Up Substation, which will raise the generation voltagem from 13,8 kV to 345 kV, providing the interconnection of each generating unit to the double bus bar. This substation will be interconnected to an interconnection substation, which will be connected to FURNAS Transmission Lines.

The Interconnection Substation will basically comprise a switch substation with a one and a half circuit breaker configuration, two lines inlet and four

outlets. These lines' outlets will be interconnected to the 345 kV lines of FURNAS by four Interconnection Transmission Lines.

The two existing Transmission Lines of FURNAS, which interconnect the Substations of Adrianópolis and Campos, will be sectioned by the insertion of a tower in each line and, subsequently, after the start up of Macaé TPP, theirs jumpers will be removed, when the lines will be sectioned.

The interconnection between the Step-Up Substation and the Interconnection Substation will be performed by a flexible bus bar, composed by two tramos, each one interconnecting each bus bar, mounted on tower or gantry support types, with a route to be defined by the executive project.

The Step Up Substation of the plant will basically comprise an interconnection substation for interconnecting all generating units to the 345 kV system.

The plant will comprise 16 generating units that will be interconnected to the 345 kV bus bars, in pairs, by means of a step up transformer 13,8/345 kV. All eight transformers will be interconnected to both bus bars. The bus bars will be interconnected by means of transfer circuit breakers.

5.10.2.2 Characteristics of the Substations

Macaé TPP will be composed by 16 generating units that will be interconnected in pairs to a step up transformers which, in turn, will be interconnected to two bus bars.

The step up substation is designed in order to allow each generating unit, a set of generating units or all of them to operate in order to make use of both the bus bars or only one of them for transferring from the generation to the transmission system.

The step up substation must be connected to the Interconnection Substation by means of two flexible bus bars, approximately 300-m long, each, with 2 ACSR conducting wires per phase, with a minimum diameter of 40 mm.

The Interconnection Substation will be set in order to allow the interconnection between the existing Transmission Lines and between the Plant and the Transmission Line, so the power generated by the plant can be transferred to the Interconnected System or, if the plant is not operating, the electrical continuity of the lines is allowed.

5.10.2.3 Basic Description of the Substations

The Step-up substation will provide the interconnection of the generating units to the interconnection substation. It will basically comprise a double bar and

single-circuit breaker unit, composed by 8 (eight) step-up transformers (13,8/345 kV), triple-coil, 11 (eleven) circuit breakers (345 kV), 22 motorized sectioning-switches (345 kV) and two transforming units for measurement.

Each pair of generators will be provided with a transformer, with a proper step-up ratio (13,8 kV to 345 kV). They will be oil-cooled transformers (maximum temperature of 65 °C, for an average room temperature of 30 °C),and the cooling oil will flow through fin-coolers, provided with fans for induced air-cooling, which will work when the transformer operates at higher power ranges. Each transformer will be grounded: the primary coil will be grounded by a star-type grounding, the secondary one with a delta-type and the whole set will be provided with a tap for voltage changes**.** The transformer's impedance will lie within the limits established by the Brazilian manufacturing standards (ABNT).

The interconnection substation will be a one-and-a-half circuit breaker type with 6 x 345 kV circuit breakers, 12 motorized sectioning switches and 4 motorized sectioning switches with grounding blade (345 kV).

The support structures of the bus bar and other equipment will be constructed of galvanized steel. The rigid bus bars will be made of aluminum pipelines, while the flexible ones will be made of aluminum wires.

Physical Characteristics

The main electric characteristics of the substations are:

Rated voltage 345 kV
Maximum voltage 362 kV
Frequency 60 Hz
Current at the bus bars 2000 A
Tri-phase short-circuit current and
Grounding-phase 40 kA
Short-circuit duration 1.0 s
Min. diameter of the bus bar pipes 140 mm
Arrangement f the flexible bus bars 2 conductors per phase, 400 mm from each other
Min. diameter of the conductors 40 mm

5.10.2.4 Detailed Project, Supply, Construction and Assemblage

Detailed Project

The detailed project will be performed by the company responsible for the supply, construction and assemblage. The project will be presented to FURNAS, which, according to the present legislation (Resolution No. 433 of ANEEL) must analyze and approve the project, which will be then developed based on the specification and definitions of FURNAS, either regarding the Interconnection SE or the Interconnection Lines. The project will also comply with the regulations established by the Network Procedures of the National Operator of the Electric System (ONS) and by ANEEL.

Supplies

All materials and equipment will be acquired in the national market by the Contractor and must be the best-quality ones. Their trademarks and manufacturers/vendors must be previously approved by the Owner, in strict compliance with the Technical Specifications of the Project. In case of difficulties on acquiring these items in the national market, especially regarding delivery terms, they can be imported and submitted to the approval of the Owner.

5.10.2.5 Construction and Assemblage

Scope of the Services

The construction of the Substations will basically comprise the following services:

a) Provisory facilities of the construction site;

b) Preparation of detailed projects for civil works, electro-mechanical assemblage, etc.;

c) Construction and/or enhancement of the access ways;

d) Load, transportation, unload, storage and conservation of all materials, from their delivery to their utilization or return;

e) Topographic implementation;

f) Execution of foundations, streets, gutters, fences and gates, control rooms, pebbling the yard, etc.;

g) Assemblage of equipment, bus bars,etc.;

h) Assemblage of panels, boxes, power cables, control, command and communications

i) Assemblage of the grounding system, including grounding networks;

j) Complete revision of all performed services;

k) Final tests and commissioning;

l) Recovery and reconstruction of all interferences to the soil and environment, bringing them back to the existing conditions prior to the works;

Organization

The Contractor will be responsible for organizing the construction site, which will basically comprise:

a) Providing the supervision and management of the services, manpower, transportation, tools, construction and assemblage equipment, testing instrumentation, general materials, consumption materials and other required items;

b) Organization chart of the works, down to the level of chiefs in charge, with different assignment for all different areas/functions;

Operation and Maintenance of the Construction Site

The construction, operation and maintenance of the construction site, lodging areas, cafeterias and other facilities required for the works of the Contractor, including water and power supply, sewerage, transportation of personnel, sentry, medical care, industrial safety and hygiene services, maintenance of storage areas and warehouses, workshops, kitchen, pantry and any other facilities required for the proper functioning of the site, will be a duty of the Contractor.

Procedures of the Construction Site

Procedures will be established for the operation of the construction site, including, but not limited to, the following ones, which will be reviewed as required:

a) Identification:
All vehicles must be clearly identified by the name of the Contractor placed at the windshield;
b) All personnel involved with the services of the site must permanently wear an identification card, including name, function, Contractors' name and a picture of the employee;

Fire Fighting and Protection

The Contractor will be responsible for the protection of all facilities of the construction site against fire, installing all required equipment and devices;

Industrial Safety and Hygiene

The disposals of the Document “Normas de Segurança e Higiene Industrial” (Standards for Industrial Safety and Hygiene), presented in Annex 1 at the end of this Section, will be strictly followed.

The workers must wear adequate shoes, approved helmets and clothes whenever working at the construction areas;

Communication media

The Contractor must provide, at its own expenses and before the adequate officials, the installation and operation of the required communication media.

Ownership of the Construction Site Facilities

All provisory facilities of the construction site will be owned by the Contractor and must be removed from the area at the end of the works. The areas must be left clean and clear, including the demolition of foundations. The area environment must be returned to the original conditions existing before the implementation of the construction site;

Quality Control

The Contractor is responsible for the quality of the provided services, which will be controlled by a specific team, previously approved and compatible with the nature and extent of the works, which must meet the following minimum requirements:

a) The Quality Control team will be independent of the production structure, reporting to the highest hierarchic level of the Contractor;

b) The team will be composed by technicians with a strong knowledge on the scope of the services, execution drawings, technical specifications and technical regulations applicable to the services;

c) The team will be provided with facilities and equipment adequate to the development of its tasks or it will hold

agreements with specialized technical organization, provenly qualified, in order to perform the required essays;

d) The Quality Control activities will be supervised by the Owner of the project or by a person assigned by them, whether by performing parallel essays or by performing audits in the implemented system;

Procedures with Materials

The materials belonging to the scope of the Contractor will be delivered in the Construction Site. After received, these materials will be handled, preserved and stored for further transportation to the installation areas, by and under the responsibility of the Contractor, which will keep a permanent logging of the aforementioned materials and will follow the procedures listed next:

a) Storage:

All materials and equipment delivered in the construction site and destined to the construction, installation or assemblage will be stored in dry, sheltered areas. The storage must be arranged, classified and controlled in order to allow an inventory at any time.

Packaged items must be kept in their original packages until their utilization. Boards and panels must be stored in sheltered areas and their warming resistances must be temporarily plugged to power sources. Large equipment, such as transformers, must be unloaded directly on their definitive foundations.

b) Transportation

The transportation of all materials, as well as the return of surplus, must be coordinated with the field teams, preventing any shortage of materials in the site, also preventing that unused materials remain in the working areas, not meeting the required storage conditions.

Special care will be taken during the transportation of fragile equipment that could be damaged if improperly handled.

Working Methods

The services will be performed in compliance with pre-established criteria and, specially, in compliance with the criteria indicated at technical drawings and specifications. The working methods will be a free alternative of the Contractor. Special care must be taken in order to eliminate risk to third parties, as well as to employees that could take to unsafe or non-productive situations.

Services in Powered Areas

Services performed in or close to powered areas must be preceded of a special authorization issued by the responsible officials. The working areas must be isolated and special care will be taken regarding the utilization of tools and personal protection devices.

Site Logbook

A Logbook will be kept, composed of sequential, numbered sheets, with copy-sheets, for logging daily occurrences (summarized description of the performed works, received service orders, warnings, climatic conditions, paralyzed manpower and others). The sheets will be noted and signed by the authorized representatives of both parties on a daily basis.

Professional registration and Licenses

The Contractor is responsible for effect the licensing of the services before the Regional Council of Engineering, Architecture and Agronomy – CREA as well as to obtain the Construction License before the Municipal Administration .

Project Drawings and Documents

All contracted project documents will be provided to the Contractor, which will assess them in order to check the existence of errors por omissions that could restrain or difficult their work. In case of conflicts or omission in the project documents or in case of doubts related to their interpretation, the design company must be consulted for the proper explanations.

After the completion of each step of the works, the Contractor must forward to the Owner a complete set of all drawings, instructions and specifications with all notations related to all changes occasionally performed and previously authorized, reproducing them in order to faithfully represent the executed services. If no changes were performed, the drawing must include the following notation: Executed Without Modifications.

Ownership of Projects and Drawings

Any drawings, specification or other documents provided to the Contractor will continue to be a property of the Owner and the Contractor is not allowed to make use of them for other purposes than those that motivated their supply.

Planning, Scheduling and Physical Control

The planning, scheduling and physical control of the services' development will be based on toe contract timetable and on the executive timetable.

A fortnightly scheduling of the services to be performed must be prepared, in order to mirror times, sequences and milestones in the executive timetable. This schedule will guide the works and will comprise:

a) Scheduled works for the fortnight period;

b) Predicted manpower;

c) Distribution of construction equipment;

d) Predicted production and consumption.

A physical-control system will be established for the works execution, in order to allow the follow-up of the works, identifying delays and allowing defining and dealing with problems within an adequate timeframe.

The quantities of services actually produced will be controlled and noted in order to allow their comparison to the respective fortnight predictions. The manpower will be also controlled, as well as the utilization of construction equipment, by means of a form to be monthly issued, containing:

- Monthly manpower, withdraws, vacations, retainments and dismissals.
- Number of worked hours, per equipment, including paralyzations and off-service hours.

Environmental Protection Measures

All valid regulations and laws will be met regarding environmental protection. All procedures addressed to prevent and minimize the negative impacts of the works on the environment will be taken. These procedures must comprise, but not be limited to, the following:

a) Land clearing and earthworks, when required, but be strictly restricted to the required areas. The local vegetation covering of all other areas will be preserved.

b) Defoliating chemicals will be strictly prohibited for land-clearing purposes.

c) The areas leveled for future of provisory utilization will be provided with an adequate drainage system, provisory or permanent, in order to prevent the restrainment of water and associated erosion processes.

d) After the utilization of the area is discontinued, the Contractor must provide its recomposition, bringing it back to the previous natural conditions, as feasible as possible.

e) The burning of rubbish and wastes will not be allowed. These materials will be stored in a specific area until their final disposal is provided.

f) The sewerage system must be carefully planned in order to prevent any contamination of water bodies or groundwater.

g) Vehicles and equipment used in the construction activities must be properly maintained in order to prevent excess of smoke, noise and leakages. Adequate procedures must be taken in order to minimize the emission of dust due to the traffic of vehicles throughout the construction site.

Brazilian Regulations

The described services, projects and supplies must comply with all guidelines and recommendations of the Brazilian Regulations, except when clearly stated differently. The regulations usually applicable to the aforementioned services are: IEC, ASCE, NESC, ASTM, ISO, ANSI, IEEE, NEMA, AWS and AISI.

ANNEX 1

Engineering Disposals
Industrial Safety

1. COMPLIANCE WITH THE LEGISLATION

The effective legislation on Labor Safety, especially regarding the disposals of the Directive Nº 3.214, of 08.08.78, of the Labor Ministry, and its subsequent changes, which deals with Regulation Codes, must be strictly complied.

2. SPECIALIZED SERVICE ON LABOR SAFETY (SEST)

During the execution of the services, according to the total involved manpower and to the risk level of the associated activities, the Contractor must assign the Specialized Service on Labor Safety, assigning personnel resources according to Table II of NR-4 of the Directive 3.124.

3. INDUSTRIAL SAFETY PLAN

The following Safety Plans must be prepared by the Contractor:

3.1 – Basis Plan – Comprising the structure, organization and assigned manpower of the SEST and CIPA.

3.2 Specific Plan – Identifying risks, processes to be used, equipment, required Collective and Individual Protection Devices (EPI's), signaling of working areas, fire-fighting equipment, characteristics and conditions of the lodging facilities, kitchens, cafeterias and sanitary facilities, transportation and handling procedures for explosive materials, hazardous substances and flammable liquids, according to the development of the activities.

4. SAFETY INSPECTIONS

The Owner, or a person assigned by them, can perform inspections in the different working areas, in order to check the compliance with the effective legislation, as well as with Codes, Instruction and Recommendations.

5. INDIVIDUAL PROTECTION DEVICES – EPI

All personnel under the responsibility of the Contractor will be freely provided with individual protection equipment, adequate to the associated risks and under perfect conservation and functioning conditions, whenever the collective protection measures are not technically feasible or do not offer the required protection.

The workers will be trained and guided as for the adequate, obligatory utilization of the EPI's. These devices will be replaced whenever damaged or lost.

6. COLLECTIVE PROTECTION

Collective protection devices will be made available as required, according to the effective legislation.

7. SAFETY SIGNALING

The Safety Signaling must be implemented, according to the effective legislation, requiring the isolation of working areas and also aiming at the protection of third parties, where necessary.

8. FIRE FIGHTING

Fire fighting and protection equipment must be made available, according to the effective legislation, and all personnel must be trained for fire-fighting procedures.

9. TRANSPORTATION OF PERSONNEL

The transportation of the workers will be performed under maximum safety conditions, in compliance with all legal requirements, The transportation of personnel using improper vehicles or under risky conditions will not be allowed.

10. PROVISORY FACILITIES

The provisory facilities will comply with the effective legislation and special care will be taken to the sanitation of lodging areas, locker rooms, kitchens and cafeterias and to other aspects related to Sanitary Engineering.

11. HAZARDOUS SUBSTANCES

A list of hazardous substances must be issued, including radioactive materials and explosive substance that could be used in the area, informing the required utilization and stored inventory, complying with the existing legislation related to the transportation, utilization and disposal of these materials according to the Labor, Transportation and Army Ministries and to the National Commission on Nuclear Energy , as well as with other established restrictions related to these matters.

12. REPORT ON WORKING ACCIDENTS

All working accidents must be communicated by means of a proper form (“Relatório de Acidentes de Trabalho”).

13. CIPA

The Internal Committee for Accidents Prevention (CIPA) must be established, according to the effective legislation. The Contractor must be represented in the CIPA meetings, if necessary (according to the number of employees).

5.11 EARTHWORKS

The earthworks' project was already presented to FEEMA, which analyzed and granted the specific Installation License for that activity. Nevertheless, a general description of this project is present here, in order to provide an overview of the whole project. The earthworks' drawings are displayed in Volume 2, Annex VII.

5.11.1 DESCRIPTION OF THE SERVICES

The earthworks comprise the creation of 3 plateaus: a main one to be leveled at elevation + 30,5 m (about 75.000 m^2) where the plant will be installed, a secondary one, to be leveled at elevation + 15,0 m (about 9.000 m^2) where the future substation will be implemented and a third one, at elevation +11,0 (about 30.000 m^2) that will be used for the temporary storage of equipment during the plant construction.

The arrangement of these plateaus is depicted in drawings NT-PLT-001 and NT-PLT-005, and the forecasted earthworks' volumes are 1.300.000 m^3 and 760.000 m^3 for cut and fill, respectively. No external borrow pits will be used and the whole exceeding cut-and-fill volume will be properly disposed within the site area. Considering the compactness level to be applied to the filled areas, which requires a higher volume of material, the final exceeding material to be disposed is estimated in 300.000 m^3. The environmental cares to be taken during the execution of the works are described in the General Notes of Drawing NT-PLT-001.

The predicted access way is 1.322 m long, connecting BR-101 to the Equipment Area, with 820-m over an alluvial plain area. The access to the substation area will be 340-m long.

5.11.2 EXECUTIVE METHODOLOGY

The implementation of the aforementioned plateaus will be based on intense earthworks, followed by the implementation of a drainage system and protection measured addressed to natural ands created slopes.

In order to implement the main plateau, the activities must start by the creation of working fronts and service accesses, simultaneously to the implementation of the required drainage points, After that, the land clearing activities occur, including the removal of the surface vegetation layer from the accessed areas. These activities advance slowly in order to prevent exposing a large area that could not be totally excavated in the subsequent steps.

The services comprised by this step include excavating, loading, transporting, unloading and spreading the vegetation layer onto the site area.

The subsequent activities, required for configuring the land as required by the project, comprise excavating, loading, transporting, unloading and spreading the material (considered as 1st class material) onto the filling areas. The filling activities must first be addressed to lower areas, so well defined drainage plans can be accomplished.

After spreading the filling material, which will be laid into uniform layers, never thicker than 300 mm, the subsequent activities can be started, comprising the homogenization, treatment for humidity control by aeration or wetting, according to the case, and the area compacting, until the design criteria is reached, in addition to levels and slopes defined by the project, also.

As the cut and fill activities reach the established elevations and the resulting slopes are completes, the vegetation recovering starts, addressed to ensure the consolidation and protection of those slopes.

The earthworks required for implementing the secondary plateaus and the access ways would basically follow the same guidelines and sequences observed for the main plateau. However, since the geological-geotechnical characteristics of these areas are different than the main plateau one, involving peaty, flooding soils, the earthworks of these areas will be preceded by the removal of the vegetation layer and the underlying soil up to a depth of 50 cm. This layer will be then replaced by 50-cm thick draining layer of sand, imported from a lode close to the site. This draining layer will be covered by a geo-textile blanket as defined in Drawings NT—PLT-002 and NT-PLT-004. In addition to this, protection, consolidation and restrainment measures will be taken for this area by creating berms and implementing a vegetation recovery, according to the recommendations of the geotechnical project.

The exceeding material will be disposed within the site area in the areas indicated in drawing NT-PLT-001, forming 3-m high volumes with slopes of 2:1 (H:V). These volumes will be recovered with vegetation for erosion control purposes. These areas will be landscaped in accordance with the general landscaping project of the plant.

Simultaneously to all aforementioned activities, a whole set of drains, pipelines, troughs, collection boxes, settling basins will be implemented, in order to properly drain the working areas and temporary accesses, as well as the entire land in his final shape and the definite accesses. The drainage devices will be designed for downpours and recurrence times of 5 years, for surface drainage, and 15 years for culverts. The rainfall data were obtained by a set of data provided by ANEEL- Station 02241002 Macaé RJ and, by means of rainfall equations of FUNDERJ for observations performed for the period 1944-1978, rainfall indexes of 51 mm/h and 71 mm/h were obtained for the aforementioned recurrence times, respectively, taking to extreme flow rates to be drained of about 3,5 m^3/s. These measures, with other preventive procedures and measures, compose the Erosion Control Plan, established in the General Notes of Drawing NT-PLT-001. Detailed drawings of the area

drainage (NT-DREN-001 and NT-DREN-DET-001), are presented in Annex IV – Volume 2.

5.11.3 INFRASTRUCTURE REQUIRED FOR THE EXECUTION OF THE WORKS

Considering the intense mobilization of construction equipment, material and human resources required for performing the earthworks according to the desired timeframe, annexed to this document, a set of temporary facilities will be required addressed to the management, maintenance and general support to the involved services.

These facilities (management, maintenance, laboratory, medical care and safety) will be installed in wheeled containers, completely fitted with furniture, computers and communication facilities, air conditioning and sanitary facilities. In addition to these elements, a sentry box, a sheltered area for maintenance of vehicles, sanitary facilities, locker room and cafeteria will be implemented, as displayed in Annex VIII - Volume 2 “Lay Out of the Construction Site”, whose location is indicated in drawing NT-PLT-001- General Layout, in the same Annex.

The construction site will occupy an area of about 9.600 m^2, and supplied with potable water by water-trucks from Macaé. The bathrooms, comprising a total number of 6 units, will be provided with chemical-lavatories and the wastes from these units will be removed from the area by trucks and sent to the proper disposal at the sewerage treatment plant of Macaé. The power will be locally supplied by motor-generator sets. The wastewater from the sinks (bathrooms and kitchens) will be sent through pipelines to a cesspool, since they will not be characterized as a sewerage stream.

The earthworks will be supported by preventive and corrective maintenance workshops. The workshop will be also provided with a mobile-unit including office, power generator, bathroom, tool shop etc. A metallic roof will be mounted in front of the workshop (70 m^2) provided with lighting for nocturnal services.

The area will be also provided with a washing area for equipment, with a reinforced concrete ramp provided with a water-oil separation box. This area will occupy 48m^2.

The vehicles and machines will be refueled by a specific station, comprising two tanks of 15,000 liters, each. A containment basin will be constructed around this area, made of masonry and with a watertight floor of concrete, according to the effective environmental standards.

The areas addressed to the maintenance, lubrication and washing of equipment will be provided with troughs for collecting the liquid streams generated by the activities performed in these areas, which will sent to the

water-oil separation device, according to the plan displayed in Annex VII, so no pollutants will be carried to the natural drainage network.

The laboratory facilities will be addressed to physical tests, required for the technological control of the earthworks.

All workers will be lodged outside the working areas. The meals will be prepared outside the construction site and only served in the cafeteria, which will be properly designed and operated, in accordance with the best hygiene and quality standards and with the best procedures related to the final destinations of the wastes generated in this area.

In a general way, all the aforementioned facilities and operational guidelines will meet the effective standards of Labor Medicine, Hygiene and Safety, as well as specific recommendations addressed to control environmental impacts in the working areas.

5.12 ACOUSTIC INSULATION

A single cycle plant comprises several noise sources, the most significant ones represented by the combustion turbine and stacks.

During the development of the EIA/RIMA studies, field measurements were performed in order to characterize the background noise level of the site and its vicinities. Based on the results of these measurements, the noise effects of the project were simulated, considering the most critical scenario, which corresponds to the simultaneous operation of all 16 turbines of Macaé Merchant TPP and the operation of all three turbines of Norte Fluminense TPP, which must be installed in an adjacent site. The simulation took in account the standard arrangement of the equipment for Macaé Merchant TPP, i.e., a noise level of 85 dB(A) at 1 m far from the cabin wall. The “cabin”, here, comprises a carbon steel container with internal walls lined with fiberglass. The turbine is installed within this container.

As for the stacks, they were simulated without any noise abatement devices, for a diameter of 3,5 m and height of 20 m. The simulation considered the stacks positioned at the elevation 20 m.

The results of the simulation indicated an increment of 10 dB(A) to the existing background level in some spots located close to the site fences, which is higher than the increment allowed by the applicable regulations. Based on these results, the EIA/RIMA recommended that noise-abatement measures should be taken in order to reduce the noise levels in the immediate vicinities of the site. This recommendation became the restriction Nº5.12, of the Previous License LP 013/2001.

In order to meet these requirements, El Paso first performed a detailed study on background noise levels in the area, in order to define more precise basis addressed to the design of the noise abatement measures required for bringing the performance of the future plant to a level that could meet the applicable technical and legal requirements. This study was based ion a new set of measurements, whose report is presented at the tend of this Volume 1

The strategy addressed to ensure an adequate noise performance comprises three basic procedures: provide immediate adjustments to the design of the noise-generating units, most specifically generators and stacks; acquire and additional land adjacent to the site in order to expand the deafening area of the plant; and install external acoustic barriers, if yet necessary.

For the fist procedure, the following measures have been already taken:

- Increase on the acoustic protection level of the generators and new guaranteed noise levels agreed with the manufacturers, in order to meet the requirements of the Brazilian standards;

- Heightening the elevation of the project to 30 metros, preserving the higher slopes of the vicinities, in the turbines yard, in order to provide natural barriers;
- Change the design of the stacks, using 16.7-m high units, with square-sections (3,55m x 3.55m), fitted with 32' long silencers.

As for the expansion on the deafening zone, EL Paso has been negotiating the acquisition of a neighbor area (approximately 400-m wide) which would allow a reasonable displacement of the measurement area (fence).

Finally, for the third procedure, the action comprises designing additional acoustic protections, based on the effective performance of the measures already taken. In order to evaluate the new performance, a measurement campaign will be performed as soon as the first 4 generating units of the plant are activated. The results of this campaign will be extrapolated to the remaining units, establishing a precise model for the noise generation of the project and allowing the proper design of the additional measures that turn out to be still required.

5.13 ARCHAEOLOGICAL SURVEY FOR THE GAS PIPELINES ROUTE

This plan will be not considered in this document, since it will be a duty of CEG - Companhia de Distribuidora de Gás do Rio de Janeiro Ltda, which will present the survey to FEEMA with the Detailed project of the Natural Gas Distribution Pipeline, addressed to obtaining the specific Installation License of this project.

5.14 TEMPORARY DISPOSAL OF SLUDGE

Almost all sludge produced in the plant comes from the water treatment plant and, therefore, is composed by a common sludge, typical of water supply systems. With a compositions that varies along the year, according to the characteristics of the collected raw water.

A second type of sludge produced by the plant comes from the sanitary sewerage treatment process which, according to the reduced number of operation personnel of the plant (60 employees) is not considered too significant. Nevertheless, all sludge produced by the plant activities will be properly managed, in accordance with the applicable legislation.

5.14.1 SOLID WASTES MANAGEMENT SYSTEM

The solid wastes generated by Macaé Merchant TPP come from two main systems:

- Water treatment for Industrial Uses
- Sewerage Treatment

Some small amounts of oil dregs and spent lube oils will be also generated.

All wastes will be inventoried and classified in accordance with Res. CONAMA 06/88 and ABNT/state associated standards. This inventory will be part of the Solid Wastes Management Plan, to be issued by the time the Operation License is requested. The wastes will be stored in 30-m^3 containers and removed on a weekly basis by the company Irmãos Ribeiro Ltda, licensed by FEEMA for collecting this type of waste, according to the annexed Operation License.. For some special cases, such as for the spent resins and spent lube oils, the respective vendors are responsible for transporting and recycling the wastes, as established at the respective supplying contracts.

5.14.1.1 Solid Waste from the Raw Water Treatment System

The solid waste generated by the raw water treatment system is the cake refused at the press filters, which contains the suspended solids from the water collected in Macaé river and the iron hydroxide resulting from the addition of Ferric Chloride to the thickener.

The press filter was designed for a maximum content of 120 ppm of solids in the water, considering a maximum content of 100 ppm of solids and 20 ppm of Iron Hydroxide. The filter cake presents a water content of 80% and the

remaining 20% composed by the inlet suspended solids (83%) and Iron Hydroxide (17%).

A maximum quantity of 950 kg/day will be generated at the water treatment system, which takes to a total weekly load of 7 ton at the full operational capacity of the plant.

This waste will be sent to the company Plastimassa Indústria e Comércio Ltda, located at Estrada Municipal Adam Blumer, 5942, Magé. The composition of the waste was forwarded to this company, which confirmed their ability to receive the material.

5.14.1.2 Solid Wastes from the Sewerage Treatment

This waste is generated at the aerobic digestion of the process – Activated Sludge – whose last step comprises a settling operation, that takes place at the Sludge Collection Tank, where the solids from the process are concentrated before their final disposal.

At a maximum capacity, the system will produce 150 kg every two months.

This waste is kept as a fluid within the Sludge Collection Tank and every time a disposal operation is processes, the whole content of that tank is transferred to a bucket and removed by a properly licensed company. The waste can be normally used as fertilizer for agricultural purposes, except for potherb cultures.

For Macaé Merchant TPP, it is considered that this waste will be sent to the municipal landfill of Macaé.

5.14.1.3 Spent Resins

The demineralization systems described in item 5.4, makes use of ion exchanging resins that remove dissolved solids from the water to concentrations below 3 ppm. After a certain number of operational cycles, the resins are regenerated by an alkaline or acid backwash step, becoming reusable for a new cycle. However, after the resins' depletion, the process generates a hazardous solid waste at a rate up to 1.000 kg/year, which will be stored into drums in a sheltered area and recycled by the vendor.

5.14.1.4 Oily dregs and spent lube oils

The drainage from the substation, the maintenance workshop, the vehicles' refueling yard and from the Diesel containment basins (emergency

generators) will be routed to a water-oil separator, as described in 5.7. This system will generate small amounts of recyclable oil and oily dregs, since the plant will fire only natural gas.

5.14.1.5 Common garbage (office and cafeteria)

According to the total number of employees predicted for the plant, an average amount of 90 kg of garbage must be generated by the normal activities, which will be sent to the sanitary landfill of Macaé.

Sketch: construction site

6 ENVIRONMENTAL MANAGEMENT OF THE PROJECT

This chapter addresses the strategies to be taken by the entrepreneur in order to ensure the proper environmental performance of the project, as well as those addressed to control the effectiveness of the procedures, devices and technologies utilized for that purpose. It also addresses the strategies aimed at maximizing and locally inserting the benefits associated to the project, in order to offset the region where the project will be located for its associated non-mitigable impacts, especially those related to the utilization of natural resources.

This set of strategies are part of the Environmental Management System – EMS – of the project, which can be grouped according to their purposes as follows:

- Mitigation strategies;
- Monitoring and control strategies;
- Environmental offsetting strategies

In order to implement these strategies, the EMS was structured into programs, according to the mitigation, control or offsetting objectives planned for the project.

Therefore, the EMS is composed by environmental impacts mitigation and/or prevention programs, monitoring and control programs addressed to the environmental performance of the project and offsetting programs.

The Environmental Management System were recently regulated in Brazil by means of NBR ISO 14000 standards, which are based on international environmental management standards and regulations.

The proposed system complies with those standards and includes a definition of an organizational structure, duties, methods, procedures and resources addressed to the implementation of the environmental management, also stating the targets of the entrepreneur's environmental politics regarding the project environmental performance.

As for the organization and duties required for the implementation of the EMS, all environmental programs specified at this Basic Environmental Plan of Macaé Merchant TPP will be fully performed by the entrepreneur or by third parties under its responsibility. The purpose on organizing environmental programs under a systemic structure is enabling an integrated management of the programs execution, while permanently managing their interfaces and checking, along the whole process, the fulfillment to dates, methodological approaches regulated or agreed with the Environmental Agency and to the applicable environmental requirements.

It is a responsibility of the proposed system the continuous checking and evaluation of the effects of the activities, products and services related to the project on the environment, along its entire installation and operation cycles, including logging and documenting this process.

In order to implement an adequate management of environmental-affecting problems during the implementation and operation of a large project such as Macaé Merchant TPP, it is required that the proposed organization structure mirrors the commitment of the project upper management and leaderships in ensuring the environmental performance assumed during the planning and licensing steps of the project.

To that end, an Environmental Supervision Unit will be assigned and empowered to interfere in the implementation and operation processes of the project. This unit will be responsible for the full execution of the EMS, being formally assigned as part of the organizational structure of the project.

The Environmental Supervisor will perform technical activities related to the internal ambit of the company and to the technical management of third parties, assigned for specific tasks belonging to the programs of the EMS. The supervisor will be also responsible for the interfaces with the Environmental Agency regarding formal por demanded demonstrations of the results of the programs.

As for the external environmental relationships, involving contacts with the community or institutions not belonging to public environmental agencies, the Environmental Supervision unit of the project will be supported by skilled technicians from public relations areas or external specialists, involved with the Social Communication Program.

All environmental programs proposed here will be related to the Environmental Management System and the persons responsible for their execution must report directly to the Environmental Supervision Unit during the entire development of their activities.

The Environmental Supervision Unit will be also supported by a SHE professional, who will coordinate the execution of the internal activities of the project related to this area, providing the fulfillment to all operational targets and standards defined by the SHE politics of the project, while checking, logging and reporting their fulfillment.

The Environmental Supervision Unit will have the following duties:

- Providing to all involved sectors the information required for operating the environmental management;
- Organizing the environmental management, involving those sectors by means of CIPA/CIMA;
- Supervising the definition of targets to be maintained/met in each sector of the organization, based on official and corporate standards and regulations;

- Generating internal standards and procedures as manuals, bulletins and guidance cards;
- Supervising the monitoring of emissions and effluents performed by the corresponding sectors, aiming at controlling the operations as logging the results;
- Monitoring environmental quality parameters influenced by the project, as defined by the Environmental Agency, logging and evaluating the results on a permanent basis;
- Supervising the actions taken as part of all proposed environmental programs;
- Providing subsides to the upper management addressed to the re-evaluation of the results of the performed monitoring and auditing activities, whenever necessary.

In order to check the functioning of the Environmental Management System, internal environmental audits will be performed, addressed to the maintenance of the environmental quality standards and to checking the effectiveness of the system.

The monitoring of the parameters generated by the environmental programs will be fed into a database, aiming at establishing a dynamic evaluation and adjusting system addressed o the performance of the different environmental interfaces of the project. In order to achieve this purpose, databases will be simultaneously kept for:

- Logging of accidents and improper functioning, including analysis of causes and consequences;
- Documentation related to suppliers, vendors and contractors, including utilized consumption products, log of events, etc.
- Documentation related to consumption products, indicating storage and handling areas and methods, physical-chemical characteristics, recommendations for storage, handling and transportation, procedures for accidents and emergencies, effects on the human health, report on events occurred within or related to the TPP, etc.

Based on the organization here presented and on the established mitigation/monitoring and offsetting purposes for the evaluated project, the EMS will be structured as follows. The timetable and Budget schedules of the EMS are presented following the system structure, indicating the compliance with the restrictions of the Previous License for the different programs.

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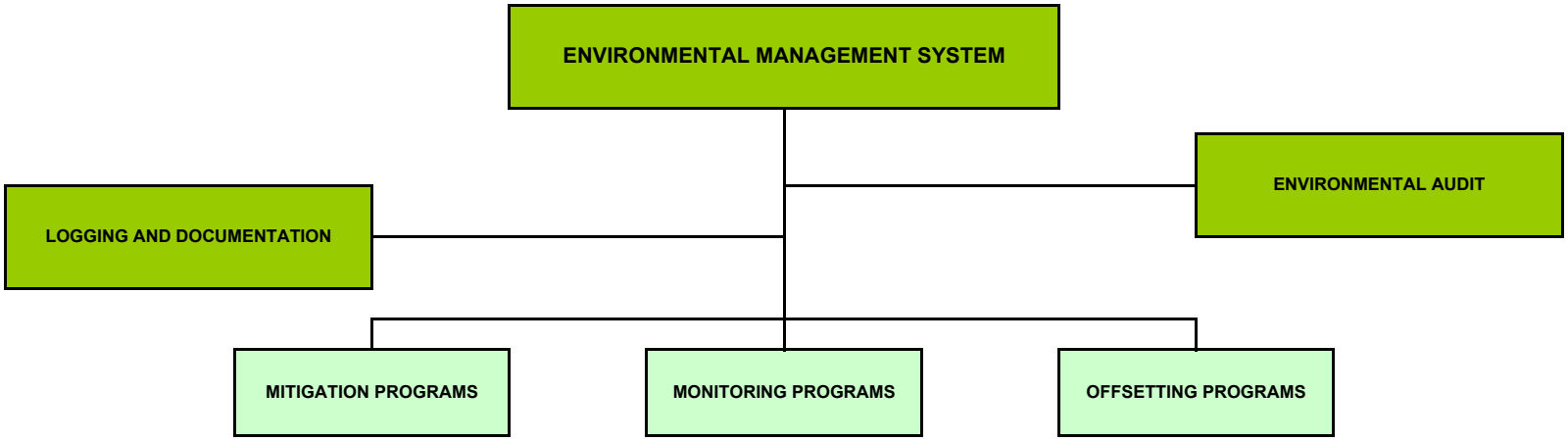
ENVIRONMENTAL MANAGEMENT STRUCTURE SYSTEM



6.1.1 Construction Environmental Program - PAC
6.1.2 Landscaping and Recovery of Marginal Borders
6.1.3 Risk Management Program
6.1.4 Social Communication Program
6.1.5 Manpower Contracting and Demobilization

6.2.1 Noise Level
6.2.2 Air Emissions
6.2.3 Air Quality
6.2.4 Water quality
6.2.5 Effluent Quality
6.2.6 Soils and Groundwater
6.2.7 Erosion Processes
6.2.8 Solid Wastes

6.3.1 Recomposition of Riparian Vegetation
6.3.2 Handling Plan - Cons. Unit - Mangrove of Macaé River Mouth
6.3.3 Recovery of Macaé-Campos Channel
6.3.4 Hydric Availability of Macaé River Basin
6.3.5 Survey on groundwater
6.3.6 Environmental Education
6.3.7 Support to State Conservation Units
6.3.8 Support to the National Park of Jurubatiba Coastal Forest

MACAÉ MERCHANT TPP - TIMETABLE AND BUDGET - EMS								
PROPOSED PROGRAMS	RESTRICTIONS OF LP-013/2001	YEAR 1 CONSTRUCTION (1000 R$)	YEAR 2 OPERATION (1000 R$)	YEAR 3 OPERATION (1000 R$)	YEAR 4 OPERATION (1000 R$)	YEAR 5 OPERATION (1000 R$)	YEAR 6 OPERATION (1000 R$)	TOTAL
6.1 Mitigation Programs								
6.1.1 Construction Environmental Program - PAC		150						150
6.1.2 Landscaping and Recovery of Marginal Borders	N º 5.8 e 5.15	1.600						1600
6.1.3 Risk Management Program	N º 5.25	0						0
6.1.4 Social Communication Program	N º 5.28	60						60
6.1.5 Manpower Contracting and Demobilization		0						0
								0
6.2 Monitoring Programs								0
6.2.1 Monitoring Program on Noise Level	N º 5.21		20	20	20	20	20	100
6.2.2 Monitoring Program on Air Emissions	N º 5.20	1.500						1500
6.2.3 Monitoring Program on Air Quality	N º 5.19	1.500	300					1800
6.2.4 Monitoring Program on Water quality	N º 5.18	80	50	50	50	50	50	330
6.2.5 Monitoring Program on Effluent Quality		0	100	100	100	100	100	500
6.2.6 Monitoring Program on Soils and Groundwater	N º 5.22	40	20					60
6.2.7 Control Program on Erosion Processes	N º 5.24	0						0
6.2.8 Monitoring Program on Solid Wastes	N º 5.23		50	50	50	50	50	250
								0
6.3 Environmental Offsetting Programs								0
6.3.1 Recomposition of Riparian Vegetation	N º 5.15	1.600						1600
6.3.2 Handling Plan - Cons. Unit - Mangrove of Macaé River Mouth	N º 5.16	200						200
6.3.3 Recovery of Macaé-Campos Channel	N º 5.17	1.500						1500
6.3.4 Hydric Availability of Macaé River Basin	N º 5.26	270						270
6.3.5 Survey on groundwater	N º 5.27	180						180
6.3.6 Environmental Education	N º 5.28	250						250
6.3.7 Support to State Conservation Units	N º 5.29	3.000						3000
6.3.8 Support to the National Park of Jurubatiba Coastal Forest	N º 5.30	1.000						1000
TOTAL		**12930**	**540**	**220**	**220**	**220**	**220**	**14350**

6.1.1 ENVIRONMENTAL PROGRAM FOR CONSTRUCTION

6.1.1.1 Objectives and Justifications

The project construction could generate additional impacts on the environment, if adequate procedures are not followed. In order to reduce those impacts, rules and procedures have been established for each construction step of the thermal power plant.

The Environmental Program for Constructions – EPC, has the following objectives:

- To prevent and control possible spillages of pollutants during the construction and assemblage services;
- To make aware, discipline and establish a partnership with the workers involved in the construction of the power plant regarding the protection of both the fauna and flora of the regions affected by the project;
- To guide and manage the destination of solid and liquid wastes;
- To standardize the lubrication and refueling system of vehicles;
- To establish adequate actions addressed to environmental protection and technical criteria to be used throughout de TPP construction;

6.1.1.2 Procedures

The EPC for Macaé Merchant TPP includes detailed actions addressed to managing the environmental compliance during the construction steps. The programs propose responses to emergencies during the project construction, while providing guidance to the processes addressed to the mitigation of the construction activities that could potentially impact the environment.

The main actions and procedures to be taken during the plant construction are presented next. An environmental inspector assigned by the entrepreneur will be responsible for overseeing the works and checking for the fulfillment of the proposed environmental protection measures.

AFFECTED ENVIRONMENTAL ELEMENTS

a- Air Quality

Impacts on air quality during the construction step will be mainly caused by automotive combustion emissions from vehicles/equipment and to dust from earthworks, material handling and traffic of vehicles/equipment from/to and

around the construction site. The following mitigation measures will be taken in order to minimize these impacts:

- Whenever possible, construction materials will be acquired in local lodes;
- The contractor will select and utilize equipment designed for minimizing the emission of dust;
- A visual monitoring of the dust production activities will be performed during strong winds periods, followed by adequate mitigation measures, such as restriction/prohibition of those activities, water sprinkling, covering or stabilization of materials' heaps, etc.;
- The generation of dust from the materials' heaps will be managed by using water sprinklers during storage and handling activities;
- Whenever possible, unloading heights will be minimized during the materials' delivery operations;
- Access ways and areas will be properly maintained during the development of the works;
- The speed of the vehicles on unpaved ways will be restricted to 20 km/h;
- The trucks used for transporting construction materials and wastes will be covered when going through external ways.

b- Surface Water Drainage and Water Quality Protection

The control of the local surface water drainage during the construction steps will comprise the design and installation of drainage devices, such as containment ponds for stormwater, chutes and troughs; stabilization of the affected areas (slopes and disposal areas); water-oil separators for potentially contaminated stormwater streams and the implementation or erosion control measures. The specific measures to be implemented in order to control the surface water drainage include:

- Implementation of terraces for minimizing long, continuous slopes;
- Stabilization of construction accesses, internal ways, parking areas and disposal areas;
- Implementation of a system of drainage chutes and troughs;
- Positioning of temporary fuel storage tanks/containers on waterproof surfaces, provided with secondary containment structures, designed for 110% of the tanks/containers volumes;
- Positioning of pumps and equipment onto contained platforms or within secondary containment structures;
- Routing effluents from vehicles washing through settling tanks and water/oil separators before the disposal;
- Collecting potentially contaminated stormwater and wastewater streams from the concrete dosage plants of the facilities, routing those streams to settling ponds and water/oil separators before the disposal;
- Utilizing septic tanks systems for the sewer from the offices and workers' lockers;

- Implementing all adequate settling and erosion control measures prior to the start of the construction activities, aiming at the full protection of water bodies;
- Routing stormwater streams from the working areas to settling devices and water/oil separators (as required) before the disposal into water bodies;
- Temporary storage of fuel in areas provided with secondary containment and far from water bodies;
- Storage of bituminous materials (pavement of roads) into contained areas;
- Positioning of concrete plants and disposal operations far from water bodies, whenever possible.

c- Noise and Vibration

Impacts caused by noises and vibrations generated during the construction activities on critical receptors outside the site area must be minimal due to the distance to the site area and to the typical temporary characteristics of noise generating activities. Nevertheless, the following mitigation measures will be taken:

- Silencing exhausters will be used for motorized construction equipment;
- Mobile equipment and vehicles must be properly driven, respecting a speed limit of 20 km/h within the site area;
- Nighttime construction activities (10:00 PM – 06:00 AM) will be regularly restricted to relatively silent activities.

d- Groundwater and Soils Protection

Construction activities can potentially impact the soil topography, composition and the water infiltration rates due to operations such as soil compaction, removal of the upper layer of soil and temporary/permanent redistribution of the soils during leveling and excavation activities required for foundations. In order to protect the soils and the existing hydrogeological conditions, the following mitigation measures will be taken:

- Local drainage devices will be implemented, deigned for collecting, equalizing, treating (as required) ands controlling the discharge of stormwater in the area;
- The access of personnel and vehicles to areas not assigned for construction purposes will be restricted, in order to prevent any unnecessary or accidental disruption or soil compaction;
- Rubbish and other construction refuses will be controlled so any materials that are not adequate for a local reuse or for utilization for other purposes will be disposed into licensed landfills;

- All areas used during the construction and available after its completion will be recovered to conditions close to the previous, original ones or equivalent to those;
- The management of the excavations will be performed in order to prevent drainage pathways toward subjacent aquifers.

e- Fauna and Flora

The construction activities in the site area should not impact significantly the areas addressed to nature preservation. Nevertheless, mitigation measures will be implemented, aimed at the general protection of fauna and flora elements in the project area:

- Overall losses of habitats will be minimized as much as possible;
- A landscaping project will be implemented after the works completion;
- The drainage of the site will be collected, controlled and disposed in accordance with the mitigation measures previously described.

f- Waste Management

A variety of wastes will be produced during the construction activities. The external facilities contracted for recycling, treating and disposing solid wastes generated by the construction step will be subject to a pre-contract inspection and to periodic inspection throughout the construction step. In addition to this, the following management procedures will be taken, applied to each specific type of wastes:

Land clearing wastes

- All commercially useful materials will be saved during the land clearing, such as wood for construction or lumbering purposes.
- Whenever applicable, green wastes, such as the vegetation from the site and accesses clearing, must be used as an erosion control layer for the soil, for minimizing dust emission from the exposed soil or for further utilization as revegetation media of the area.
- Any additional, non-useful wastes generated during the land clearing activities must be disposed in licensed landfills.
- Land clearing wastes must not be burned in open areas.

Sanitary wastes

Sanitary wastes should be collected and temporarily stored into airtight septic tanks. These tanks will be regularly depleted and the collected wastes will be sent to either a treatment plant or a sanitary landfill.

g- Transportation

Transportation issues during the construction step are related to the safe, efficient transportation of personnel and material through all access ways, as well as to the minimization of delays and other disturbances to local traffic patterns. The following measures will be taken during the construction:

- The routes prescribed for the construction traffic must be discussed and agreed with the corresponding local officials in order to minimize disturbances to the normal local traffic. This measure must be especially important for Heavy Vehicles, which will require the indication of the prescribed routes;
- Prior notifications will be given to the local officials and newspapers (as required) regarding the delivery of "special loads" (such as turbines, generators, transformers, etc.);
- Buses or minibuses will be used for transporting the workers to and from the site.

h- Environmental Attitude of the Workers

The workers must meet and comply with regulations and procedures related to health issues and to the minimization of wastes generation at the working areas, construction sites and access ways.

Hunting, commercializing, holding or maltreatment of wildlife will not be allowed in any circumstance. The workers will be discouraged on keeping pets in the site, since these animals are usually abandoned after the completion of the works. The extraction, commercialization and maintenance of native animal species won't be allowed.

If any animal is hurt due to the construction activities, the Environmental Inspector must be notified. This person, in turn, will notify the inspection and the Environmental Supervisor.

Weapons will be prohibited. All equipment or pieces that can be used as a weapon will be collected back to the warehouse on a daily basis.

The workers should adhere to the wastes management and sanitation guidelines, especially regarding the non-disposal of wastes into the environment, as well as the disposal of materials generated during the maintenance of vehicles (air or oil filters, for instance).

All construction workers must undergo training sessions addressing environmental preservation, prevention and control. The following issues must be considered by the training courses: erosion control, leakage control; fauna and flora protection; community relationships; systematic control of wastes; industrial sanitation and safety.

6.1.1.3 Responsibilities

The activities considered in this program for the construction step are a direct responsibility of the contracted companies.

6.1.1.4 Involved Institutions

Although this program is a strict responsibility of the entrepreneur, the natures of its activities will present interfaces with environmental control agencies, as well as to both state and municipal administrations.

6.1.1.5 Costs Estimate

The cost estimated for this program is R$ 150.000,00, comprising the team responsible for inspecting and overseeing the program.

6.1.1.6 Time Table

This program must be implemented simultaneously to the construction step of Macaé Merchant TPP.

6.1.2 LANDSCAPING AND RECOMPOSITION OF THE MARGINAL PROTECTION LAND STRIP

(Compliance with Restriction n º 5.8 of Previous License N º 013/2001)

6.1.2.1 Objectives and Justifications

According to the EIA, this project is part of the Mitigation measures to be implemented during the Implementation Step of the project.

The project is not only addressed to the landscaping of internal and external passageways, but also to the implementation of arboreous vegetation areas along the fences, to the formation of arboreous groves in the lands surrounding the facilities, in plain or undulated lands, as well as to thickening the riparian vegetation observed along part of the margins of the old bed of Macaé river, which bounds the site area at N-NE.

6.1.2.2 Procedures

Native arboreous species will be used in order to provide a visual integration of the facilities to the surrounding scenery, while playing the double role of physical barriers against the winds and acoustical protection. The thickening of the existing riparian vegetation and the implementation of arboreous vegetation along the fences can start simultaneously to the construction of the plant.

The detailed revegetation/landscaping project is presented at item 5.8 of this document.

6.1.2.3 Responsible

The entrepreneur is responsible for implementing this project, contracting a specialized company for implementing and maintaining it.

6.1.2.4 Involved Institutions

Instituto Estadual de Florestas – IEF/RJ (State forest institute)
Municipal Environmental Secretariat of Macaé.

6.1.2.5 Costs

The total estimated cost for this project is R$ 1.600.000, 00

6.1.2.6 Timetable

The project will be implemented simultaneously to the construction works of the plant and its maintenance step will be extended to the operational step of the plant

6.1.3 RISK MANAGEMENT PROGRAM

6.1.3.1 Objectives and Justifications

The Risk Management Program aims at the maintenance of Macaé Merchant TPP within accepted safety limits. The program comprises set of safety recommendations, aiming at mitigating or reducing the risks identified by the process risk analysis of Macaé Merchant TPP. The program addresses the implementation planning, responsibilities and time schedule of those actions.

The implementation of the mitigation measures recommended by the study will be only accomplished if followed by a full, continuous inspection/maintenance and training program. The main guidelines addressed to the RMP development are presented next.

6.1.3.2 Procedures

The Plan must address the following guidelines, addressed to reducing the likelihood of an undesired event and its consequences:

- Inclusion of Safety Warnings at the Operation Manual of the facility;
- Development of a periodic inspection program addressed to all critical equipment and system, including safety devices;
- Installation and certification of electrical grounding systems for all equipment of the plant;
- Development of effective predictive, preventive and corrective maintenance programs, in order to ensure the safety level of the project technical specifications related to the installation of critical systems. The program should address all systems related to the TPP, i.e., internal gas pipelines, fittings (valves, filters, etc), instruments, equipment, electric system, control loops, data communication system;
- Implementation of a procedure for logging the tests performed for the whole system in order to get the highest possible number of information on the respective systems;
- Development of an accident investigation program and a management plan for critical tasks;
- Performance of an operational and safety training addressed to the operational staff, as well as support training sessions;
- Execution of periodic audits, checking for the safety level of the facility;
- Development of a management program addressed to future process changes;

- Forecasting a permanent risk evaluation system for all changes, remodeling or expansion of the process used at the considered facility;
- Adequacy of the Risk Analysis Study (performed for the EIA) after the completion of the detailed project and before performing any tests or starting up the plant;
- Preparation of an Emergency Action Plan, addressing the accident hypothesis identified by the study, as well as establishing a time schedule for drills addressed to its implementation;
- Training the fire-fighting team, periodically updating its activities;
- Performance of drills addressed to fire-fighting purposes at least at every 4 months;
- Preparation of an action time schedule addressed to the implementation of the aforementioned items, indicating responsibilities and dates for executing those actions.

The general and specific measures proposed for Macaé Merchant TPP systems as part of the Risks Management Program are presented next.

CONSTRUCTION AND ASSEMBLAGE STEPS

- Adoption of measures addressed to checking handling and storage materials of equipment and materials;
- Adoption of a quality certification check-list for materials manufacturing and receipt;
- Checking welding materials and procedures;
- Contact all officials and institutions involved with emergency response procedures in Macaé (Civil Defense, Fire Dept., Environmental Secretariat, etc), presenting the construction plan of the project and defining action strategies addressed to occasional accidents during the construction step.

OPERATION STEP

- Training the operational personnel on emergency response situations;
- Whenever a change is verified in a certain system, the operational team of this system must be kept informed about the operational routines, in order to prevent wrong decisions to be taken;
- The Emergency Response Plan must be continuously updated, comprising, whenever necessary, the joint action of the Fire Dept. Civil Defense, etc.;

- The service team must be continuously prepared for emergency situation, presenting an adequate, prompt and efficient knowledge of the situation;
- Implementation of safety signaling (including an emergency phone number).

The risks of fires, explosions, leakages or other accidents that could take to an emergency event are always present in industrial facilities, despite the safety measures in place. Therefore, it is always important to develop an Emergency Action Plan for industrial facilities, addressing the organization and training of teams and employees, in order to make them capable of respond to emergency events.

The Emergency Action Plan must be developed based on the information provided by the risk analysis study of Macaé Merchant TPP. The plan must comprise specific actions addressed to controlling emergencies potentially generated by the accidents' scenarios considered by the risk analysis study.

The following guidelines are highlighted:

- Identification of the accidental scenarios supposed to be controlled by the plan;
- Application of the plan;
- Description and quantification of emergency response equipment and alarms;
- Creation of the emergency response team and organization;
- Development of emergency procedures for the following risk cases:
  - response to leakages;
  - fire and/or explosion;
  - nature risks;
  - emergencies outside the site;
  - risks to the community.

The following aspects should be met by the PAE:

- organization structure;
- action area;
- accidental hypothesis;
- attributions and responsibilities;
- inventory and location of Individual personal protection equipment, fire fighting equipment and products abatement/containment equipment;
- communication, annunciation and alarms systems;
- alternative energy generation and distribution systems;
- list of resources from other institutions that could provide support;
- specific routines addressed for fighting every possible accident;
- procedures addressed to area abandonment and evacuation of external and internal areas.

6.1.3.3 Responsibility

This program is a responsibility of the entrepreneur.

6.1.3.4 Involved Institutions

Macaé Fire Department;
Civil Defense;
Local communication agencies

6.1.3.5 Costs estimate

The costs associated to this program will be absorbed by the entrepreneur.

6.1.3.6 Timetable

This program should be implemented during the construction step of the project, being extended along the operation step of Macaé Merchant TPP.

6.1.4 SOCIAL COMMUNICATION PROGRAM

6.1.4.1 Objectives and Justifications

This program has started during the development of the EIA/RIMA of Macaé Merchant TPP, justified, then, by the need of informing the local community about the perspectives related to the implementation of a new project in the region. The objective of the first phase of the program was providing to the local population enough information about the project in order to allow them to establish an opinion about it and to its potential impacts, whether positive or negative. At the same time, while knowing the local perspectives about the project and its impacts, the program provided and important guidance to its environmental planning, in order to ensure its adequate insertion into the region.

In the present phase, the Social Communication Program is justified by the need on keeping an open communication channel with the population, aiming at the following purposes:

- Inform the population about the content and results expected for the mitigation and offsetting measures to be assumed by El Paso during the project implementation and operation steps;
- Disclosure information related to the supervision of the implementation and monitoring of the results of these measures, while knowing the opinion of the population about the effectiveness of them;
- Keep a communication channel addressed to spontaneous manifestations of the community;
- Expand the perspectives related to the local insertion of the project, in a long term, by identifying or creating opportunities through the communication process with the local community.

It must be highlighted that the establishment and maintenance of a communication channel was also an expectation of local NGO's as verified through several contact established with the entrepreneur, including the Public Audience.

6.1.4.2 Procedures

During the initial step of the program, which were already performed, the EIA/RIMA was voluntarily sent to the community through the NGO's of MRA-5 and municipal officials of Macaé. After that, several elucidation and discussion meetings were held with those groups, even before the Public Audience. Those meetings were also used for supporting the environmental planning of the project, which took in account the feedback on environmental

issues provided by the communities. This approach established a direct communication channel with Macaé community, which will be kept as part of this Social Communication Program.

Other Social Communication initiatives taken during the first step of the program included two public presentations of both El Paso and Macaé Merchant project, one of them addressed to the commercial and industrial association of Macaé – ACIM – an a second one, addressed local business leaderships, municipal officials, NGO's and sectorial representatives. In addition to this, all the formal steps of the project environmental licensing occurred to the date were divulged in the local media.

The step of the program that has started now comprises the following procedures:

- Holding periodic meetings with municipal officials and the NGO's of MRA-5 addressed to inform about the progress of the environmental issues associated to the project, especially related to the accomplishment of the measures and programs of the EMS;
- Divulge of the progress of the implementation of the project and its offsetting measures at the local media;
- Performance of a public event right after the start up of the first set of equipment of the plant;
- Establishment of a magistracy for Macaé Merchant project, accessible to the general public;

6.1.4.3 Responsibilities

El Paso will be responsible for the Social Communication Program through its Environmental Supervisor, who will be supported by the social communication area of the company and by skilled professionals, specifically contracted for this purpose.

6.1.4.4 Involved Institutions

SEMADS;
SEINPE;
Municipal Environmental Secretariat;
Board of Members of the Intermunicipal Consortium of MRA-5; and
NGO's of MRA-5;

6.1.4.5 Costs

The total estimated cost of this program is R$ 60.000,00

6.1.4.6 Timetable

The program will last 12 months from the granting of the Installation License. The only exception relies on the project magistracy, which will be available along the whole lifetime of the project and which costs have not been included to the aforementioned estimate.

6.1.5 MANPOWER CONTRACTING AND DEMOBILIZATION PROGRAM

6.1.5.1 Objectives and Justifications

The plant construction will last 12 months. The manpower required for the plant construction will reach a total number of 650 workers at the peak of the works.

The operational step will require 60 employees, in 3 shifts.

Considered as a positive impact of the project, the generation of jobs by the implementation of Macaé Merchant plant must be structured in order to relieve the pressures caused by an occasional attraction of migrants searching for jobs' opportunities, which is likely to occur if the high unemployment rates of the country are taken in account.

6.1.5.2 Procedures

Macaé offers both qualified and semi-qualified manpower, enough to attend for the demand generated by the plant construction. Occasional additional needs should be preferably met by workers recruited in neighbor municipalities. No lodging facilities will be required, since Macaé and other close municipalities are able to accommodate workers coming from other areas.

In order to reduce the negative impacts related to contracting and demobilizing the manpower required for the implementation of the plant and enhance the positive effects of these temporary jobs, to Macaé region, the following measures should be taken:

- Local manpower should be preferred, considering the available manpower offer;
- Required, adequate training must be ensured if the appliers live in the region and match the potential profile required for the function;

In order to optimize this procedure, the appliers could be registered, providing information such as professional capabilities and skills, residence area, possibility of being trained, unemployment period and other information that could allow ranking all likely appliers for recruiting purposes.

In addition to these measures, some institutional actions should also be considered, addressed to developing agreements and partnerships with local manpower organizations (SINE, SENAI, SENAC, ACIM-Macaé, etc), in order to make use of these institutions during the recruiting process and, during the demobilization step, providing adequate transition measures such as a scheduled, previously disclosed demobilization and guiding the workers to other jobs and/or to supporting training activities.

Manpower improvement courses are also an alternative, focusing other professional areas or even addressed to engaging some workers in other areas of the plant/company.

A performance certificate should also be provided to the workers during the demobilization step, allowing the workers to present this document as a reference when searching for a new job.

6.1.5.3 Responsibilities

This program is a responsibility of the entrepreneur and must be implemented by the construction contractor.

6.1.5.4 Involved Institutions

Entrepreneur company, contractor, SINE, SENAI, SENAC, ACIM, Municipal Administration of Macaé.

6.1.5.5 Costs estimate

No additional costs are expected for contracting the manpower as proposed in this program.

6.1.5.6 Timetable

This measure must be implemented 3 months before the beginning of the construction and completed after the commercial start-up of the plant.

6.2.1 NOISE LEVEL MONITORING PLAN

6.2.1.1 Objectives and Justifications

During the plant implementation and operation, several equipment will emit noise that will change the background noise level within the direct influence area of the project, changing its environmental quality.

All noise emissions must meet both federal and state regulations, which requires a noise level below 85 dB(A) at 1 meter from the noise sources.

Standard NBR 10151 mentioned at Resolution CONAMA 01/90, establishes the noise levels according to the land use and occupation, specifying methods for noise measurement in dB(A).

According to this standard, the maximum noise levels must be 40 dB(A) for rural areas and daylight periods (6:00 AM through 8:00 PM) and 35 dB(A) for nighttime periods (8:00 PM through 6:00 AM).

The Directive GM/nº 092 (06/19/1980) also establishes that the following noise levels are harmful to the public safety and comfort:

- Noise levels that, outside the source room, reach over 10 dB(A) above the existing background level;
- Noise levels that, regardless the background levels, reach a noise level over 70 dB (A) – diurnal or 60 dB (A) - nocturnal;
- Noise levels that, within the source room, reach levels above those considered as acceptable by the standard NB-95 (ABNT).

Even considering that there are no urban area in the vicinities of the site, but only farms, the noise level generated by the plant activities could disturb the well-being of the people living or working in these areas, so the noise level monitoring becomes an important requirement.

Therefore, the noise monitoring aims at ensuring that the noise emissions will comply with both the federal and state legislation, i.e., below 85 dB(A) at 1 m far from the sources, while ensuring that the noise levels at the site boundaries will meet federal and/or international requirements, whichever is more strict, ensuring the comfort, the health and the well-being of the population around the site.

6.2.1.2 Procedures

The measurements will be performed by using a noise metering device, capable of integrating the measurements and automatically calculate the equivalent noise level.

For outdoor areas, the measurements will be performed at 1.2 m above the ground and 1.5 m far from the sources (or walls of the buildings in case on internal, housed sources).

For internal areas, the measurements will be performed at a minimum distance of 1 m from the walls, 1.2 m above the ground and 1.5 m far from the windows. In order to prevent the effect of distortions, the internal measurements will correspond to the average values of three different measurements, at 0.5 m far from each other.

The measurements will be performed for both diurnal and nocturnal periods, for weekdays and weekends, for 10 minutes, each. The measurements will be performed once a year.

The measurement areas must include those assessed during the development of the EIA/RIMA studies of the project, considering the proximity of Norte Fluminense TPP and BR-101 road. In addition to these areas, measurements should be also taken close to the noise sources.

Annual reports must be issued to the environmental agency, addressing the results of the measurement and the following additional information:

- Measured noise level, in dB(A);
- Operational conditions of the noise source and climatic characteristics during the measurement activity (temperature, direction and velocity of the winds);
- Time of the noise occurrence and associated measurements;
- Corrected noise level;
- Background level measured for the area;
- A sketch indicating the location of the measurement areas.

The measured noise levels will be compared to the limits established by the corresponding legislation, either for noise levels or to the noise levels in the environment, according to the land use in the region.

6.2.1.3 Responsibilities

This monitoring activity is a responsibility of the entrepreneur.

6.2.1.4 Costs estimate

The cost estimated for the proposed monitoring is R$ 20.000,00/year.

6.2.2 AIR EMISSIONS MONITORING

6.2.2.1 Objectives and Justifications

The utilization of natural gas for power generating purposes produces air emissions. The emissions limits of certain pollutants to the atmosphere are considered by the Brazilian legislation and must be met, in order to prevent undesired environmental impacts.

The monitoring plan proposed aims at checking if the emission rates from the stacks during the plant operation are in accordance with the limits assumed by environmental studies performed for the plant. Therefore, this monitoring plan comprises a true checking on the environmental performance of Macaé Merchant TPP.

On the other hand, the plan also aims at complying with PROCON AR, the program on air emission self-control established by DZ 545 (08/07/86) and which is part of the Licensing System for Pollutant Activities – SLAP, while meeting the restriction No. 5.20 of the Previous License 013/2001 granted to Macaé Merchant TPP.

6.2.2.2 Procedures

A *Continuous Emission Monitoring System – CEMS – will be used for monitoring the air emissions from the plant. The main purpose of the* CEMS in a stack is providing a measurement of gases outlet velocities, temperatures, pressures and flow rates, in order to allow keeping the isokinetic velocity conditions stable. During the isokinetic tests, parameters such as the gases outlet velocity and temperature are continuously monitored and the pollutants sampling rates are periodically adjusted so the gases' outlet velocities and the isokinetic velocities are kept close.

All operational testes of the system meet the *5 Test Methods USEPA*, which establishes a general protocol for automatic collection of data so the final sample is the most representative as possible of the emissions to the atmosphere. The pollutants to be sampled will comprise O_2, NO_X and CO.

The CEMS will be composed of the following equipment:

- Gases metering devices
- Particulate metering devices
- Automatic gages
- Automatic filters cleaning system;
- Conditioners for gases samples;
- Analogic and digital outputs for the control room of the gases burner
- Adjustable alarms system;
- Automatic collection and storage of data;
- General alarm system for the data.

This set allows a continuos monitoring, information collection and real-time control of the entire burning process, indicating any abnormal condition of the sampling system, such as: changes on the fuel or burning characteristics; false-air inlet, malfunction or disarrangement of the combustion process, generation of reports and spreadsheets at the control room without the interference and/or interpretation mistakes of the operators.

A total number of 16 stacks are expected for Macaé Merchant TPP. The combustion of the natural gas will generate the same pollutants for all stacks, which were designed with the same heights and diameters. The turbines where those stacks will be couples will generate the same emission rates of gases at the same time. Therefore, it can be stated that there will be no significant differences between the chemical processes of generation and emission of pollutants, since the combustion raw material is the same. In addition to this, he stacks will present the same design criteria at the sources, i.e., outlet velocity, flow rates and temperature of gases, among others.

Considering the aforementioned characteristics of the process, the continuous monitoring will be performed for each set of 4 stacks, i.e.; one CEMS will be installed for each set of 4 stacks. The remaining stacks will be periodically sampled by using portable samplers.

As requested by FEEMA at the Previous License No. 013/2001 (item 5.20), the information generated by the monitoring activities will be treated and made available on real time to FEEMA Data Center on Air Quality.

6.2.2.3 Responsibility

The proposed monitoring plan is a responsibility of the entrepreneur.

6.2.2.4 Costs estimate

The estimated costs for the installation of the proposed system is R$ 1.500.000,00. The operational costs of the system will be absorbed by the general operational costs of the plant.

6.2.2.5 Timetable

Every CEMS will be installed in the corresponding set of stacks during the construction of them. The tests and operation of the monitoring system and the set of stacks will occur simultaneously.

The proposed sampling program is displayed in the Table presented next and will comprise the following routine: the 1st sampling of each set of stacks will be performed two months after the start up of each group, being followed by a

second sampling, 3 months after the first one; a third sampling, 6 months after the second and by half-yearly samplings after that, considering a re-evaluation of the monitoring frequency to be performed at the 24th monitoring month, with the participation of FEEMA.

A technical report will be issued at the end of each sampling campaign comparing CEMS and manual sampling results, followed by a technical evaluation about addressing the coherence of the results. After a final analysis, this report will be issued to the environmental agency.

Sampling of stacks during the first two operation years of the TPP

Year	2001				2002							
Month	1 Sep	2 Oct	3 Nov	4 Dec	5 Jan	6 Feb	7 Mar	8 Apr	9 May	10 Jun	11 Jul	12 Aug
1° Set			1ª			2ª						3ª
2° Set				1ª			2ª					
3° Set					1ª			2ª				
4° Set						1ª			2ª			

Year	2002				2003							
Month	13 Sep	14 Oct	15 Nov	16 Dec	17 Jan	18 Feb	19 Mar	20 Apr	21 May	22 Jun	23 Jul	24 Aug
1° Set						4ª						5ª
2° Set	3ª						4ª					
3° Set		3ª						4ª				
4° Set			3ª						4ª			

Start up of the Stacks Set

6.2.3 AIR QUALITY MONITORING PROGRAM

6.2.3.1 Objectives and Justifications

The PRONAR (National Program on Air Quality Control) was established by CONAMA 005/89 in order to define strategies for controlling, preservation and recovery of air quality for the whole national territory, establishing definitions and guidelines for prevention and management. Subsequently, Resolution CONAMA No. 003/90 defined the air quality standards for total suspended particulates, smoke, inhaling particulates, sulfur dioxide, carbon monoxide, ozone and nitrogen dioxide.

Thermal power generation firing natural gas generates pollutants that will be dispersed throughout the vicinities of the plant, as demonstrated by the Atmospheric Dispersion Studies. These studies were based on mathematical models, considering information such as the local topography and climatic data for a selected year (Meteorological Station of Macaé Airport, 1995).

In order to check the influence of Macaé Merchant TPP operation on local air quality parameters, a monitoring program addressed to these parameters and comprising the site vicinities is proposed here.

The main objectives of this program are:

- Evaluate the air quality compared to the limits established for protecting the health and well-being of the population;
- Follow the trends and changes on the local air quality due to the changes on the pollutants' emissions of a region due to the project operation.

6.2.3.2 Procedures

Resolution CONAMA No. 003/90 defined air quality standards as the concentration values of atmospheric pollutants that, whenever exceeded, may affect the health, safety and welfare of the population, as well as harm flora, fauna, materials and the environment as a whole. Primary and secondary standards were defined for total suspended matter, SO_2, CO, O_3, smoke, inhaling matter and NO_2.

The parameters that should be regularly monitored are those directly related to the main atmospheric emissions expected for Macaé Merchant TPP, i.e.: nitrogen oxides (NOx, NO, NO_2) O_3, THC and CO.

A telemetric station will be acquired for performing the sampling and continuous analysis of the aforementioned parameters. The results will be continually transmitted to both the entrepreneur and the environmental agency, where they will be stored.

In addition to air quality parameters, the station will also monitor the following meteorological parameters:

- Wind velocity;
- Wind direction;
- Ultraviolet solar radiation;
- Temperature and relative humidity;
- Rainfalls;
- Atmospheric pressure.

The region where the plant will be implemented is a rural district, 12.5 km straightaway the central urban area of Macaé. The local present rural characteristics, with a low, sparse population occupation. According to USEPA (1987) a region is considered as urban or rural depending on the population density, ***p***, as inhabitants/square kilometers, as follows:

- Urban region: p> 750 inhabitants/km2,

- Rural region: p<750 inhabitants/km2.

The land around the site is composed by low, smooth mounds, while the north-northwest sector of the area is almost plain, composed by low, flat banks. The site area is characterized by good ventilation rates, positioned in an area higher than the surrounding lands, provided with good conditions for atmospheric dispersion.

The closer land occupations are represented by Fazenda Severina (SE the plant), 1,5k m far from the site and by Fazenda das Pedrinhas, 5,5 km southwestward the site, both comprising sparse occupations and far from each other. Generally, regions presenting characteristics similar to those verified for the site area are provided with a clean atmosphere, presenting only traces of suspended substances in the air, usually originated from natural sources.

Therefore, the region is very similar within a radius of 12,5 km from the site, especially to Southeast, Southwest, Northwest and North-northeast. Considering now that there are no significant obstacles within this radius able to disrupt the air flow that prevails in the region from NE to SW, the proposed system would comprise a station installed close to Fazenda das Pedrinhas, which comprises a discrete receptor located along the prevailing direction of the wind, comprising a representative element of the area. In addition to this, the area is provided with the minimum required infrastructure, such as safety, electricity and infrastructure for phone lines connection.

As a second location proposal, Fazenda Severina area could be considered, located 1.5 km far from the plant, to S-SE. However, this spot is too close to the emission source, being the less representative of the influence area of the dispersion emission of the plant. The annexed map depicts the location of sources and receptors, as well as the prevailing winds at the region.

Figure 1 – Location of the plant and proposed stations.

The precise definition of the areas where the monitoring stations should be installed must take in account the following aspects:

- Availability of electric energy;
- The station should not cause any discomfort to the local population;
- The area must present safety conditions regarding the long permanence of equipment
- No local pollution sources should exist close to the area, such as non-paved roads, construction works, etc;
- The area should present an adequate access for the installation and maintenance of the station.

The Automatic Air Quality Metering Station will perform the continuous measurement of both conventional and non-conventional pollutants and meteorological parameters within the influence area of Macaé Merchant TPP. The station will be composed by software/hardware able to perform the management of data, being composed by a Stationary Station and a Control Center.

The set of collected data will be transmitted by phone (dialed) to computers installed in a System Management Center, located at the plant facilities. Two terminals will be installed in the center for re-transmitting the data to EL-PASO offices and to FEEMA, after a initial treatment.

Configuration of the Proposed System

The configuration of he Sir Monitoring System is characterized next:

Table 1 – Configuration of the Stations

Items / Parameters	**Quantity**
NO_X	1 monitor + converter
NO	
NO_2	
O_3	1 monitor
THC	1 monitor
CO	1 monitor
VV (wind velocity)	1 sensor
VD (wind direction)	1 sensor
Temperature	1 sensor
Atmospheric pressure	1 sensor
Rainfalls	2 sensors
UR (relative humidity)	2 sensors

UV (ultraviolet radiation)	1 sensor
Meteorological rod	1 rod
SATD (Data Acquisition and Transmission System)	2(soft+modem +dataloggers)
Industrial microcomputer	1 unit
Cabins	1 cabin
AC devices	2 devices
Hygrothermograph (within the cabin)	1 device
Alarm system	1 system
NOBREAK	1 unit

Table 2 – Configuration of the System Management Center

Item	Quantity
Microcomputer	2 units
Data management system	2 management softwares
Consulting terminals	2
Printer	2 - Color

Table 3 – Gauging Kit

Item	Quantity
Zero air generator	1
Multipoint gauging	1
Printer	1

Table 4 – Other Important Components

Item	Quantity
Racks 19”	1 set
Stabilizer + No-breaks	1 set
Fire detection system/extinguishers	1 set
Grounded lightning rod	1 set
Probes for particulate matter and gases	1 set

The final selection on the equipment to be used for air quality measurement will be done with the support of FEEMA, in order to make the stations and monitoring results compatible with the system that has been implemented in the agency.

The sampling will be continuous and will start at least 90 days before the start up of Macaé Merchant TPP.

6.2.3.3 Responsibility

The installation of the system and its operation during the first operational year of the plan will be a responsibility of the entrepreneur. After that, the system will be transferred to FEEMA to become part of the air quality control network of the agency.

6.2.3.4 Costs estimate

The estimated costs for the implementation and pre-operation of the system is R$1.800.000,00

6.2.4 WATER QUALITY MONITORING - MACAÉ RIVER

6.2.4.1 Objectives and Justifications

Although no changes on the water quality of Macaé river are expected due to the operation of Macaé Merchant thermal power plant, the monitoring of quality parameters will be performed for this water body before the implementation of the plant and during its construction and operation steps, considering the importance of this river as a water supply source for the region.

The Water Quality Monitoring Program is justified by the need on checking the compliance of the effluents with valid legal standards, by checking the plant performance in terms of the changes on the water body at the disposal area of the effluents. The program can also provide long-term subsides to the environmental management system of the region, which is associated to Macaé river basin.

6.2.4.2 Procedures

- Initial Campaign

The monitoring will be performed in 2 points, one located 100m upstream the discharge of the industrial effluents, which, in turn, will be located upstream the water intake; and a second one located 100 m downstream the system discharge point. Both the discharge and intake points will be located upstream BR-101 bridge over Macaé river and also upstream the system considered for Norte Fluminense TPP, as depicted at Drawing BRJ034-4C0010, Annex VI – Volume II.

Two collections will be performed, one during the dry season and one during the wet season. Water quality and flow rates parameters will be determined for both stations proposed here, in order to determine also the flow rate of Macaé river.

The following parameters will be initially monitored by the sampling stations at Macaé river: turbidity, color, pH, temperature, conductivity, total filterable residues, non-filterable residues, dissolved oxygen, BOD, COD, carbonate, chloride, sulfate, nitrate, ammonia, Nitrogen Kjeldahl, silica, total phosphate, calcium, magnesium, sodium, potassium, lead, cyanide, copper, mercury, phenols, oils and greases and fecal coliforms. This list is based on the parameters previously analyzed by the environmental agency in the region, including parameters that are relevant for the operational control of the raw water treatment destined for utilization by the plant process.

In order to answer to the request of the Previous License 013/2001 (item 5.18), the biological effects of the effluents disposal will be also monitored in the ecosystem of Macaé river. This monitoring should be performed using organisms of the benthonic fauna as bio-indicators. The selection of these elements of the fauna for the considered analysis is justified by aspects such as:

- Their wide utilization in monitoring activities addressed to the environmental quality of water bodies in different regions of the world;
- The low mobility and dispersion capacity of these organism, most specifically the larva phase of the Odonata, Trichoptera and Ephemeroptera
- The existence of detailed studies on these organisms in Macaé river basin, performed by professionals of Fundação Oswaldo Cruz.

The sampling of benthos should be performed using manual bottom-scrappers and screens, in order to reduce information due to the selectiveness of collection methods.

The sampling units must be demarcated in order to define a longitudinal gradient upstream and downstream the discharge point, as well as to include a horizontal transection from the discharge point to the adjacent margins.

The filed data must be treated using richness, diversity and equitableness models. Observations on special spatial and time patterns of the structure of the benthonic communities should be performed by using multifarious comparison methods.

-

Monitoring: Construction and Operation Steps

The following parameters should be monitored during the plant construction and operation: Turbidity; pH; Temperature of the sample; Air temperature; Total suspended solids; Total solids; Oil and grease; Dissolved oxygen; Color; BOD; Al; Fe; HCO_3; CO_3; Cl; SO_4; NO_3; SiO_2; NH_4; Ca; Mg; Na; K; PO_4.

During the construction step, oil and greases, turbidity and suspended solids will be monitored in a monthly basis, and the remaining parameters will not be monitored during this step.

During the operational step, some parameters will be measured continuously, such as pH, dissolved oxygen and temperature. Suspended solids, oil and greases and chlorine will be sampled daily and the remaining parameters in a monthly basis.

The sampling and analysis methods to be used are those approved by INMETRO or, if not provided by this agency, the ones at the Standard Methods for the Examination of Water and Wastewater - APHA-AWWA-WPCF, last edition.

The analysis of parameters that require laboratory essays will be performed by companies contracted by the entrepreneur and certified by the environmental agency.

The results of this program will be made available to FEEMA and submitted to DIAG –Water Quality Division, as half-yearly reports, with data supplied by digital media, in accordance with the form model to be provided by FEEMA, including indications of laboratory analytical methods and data interpretation procedures.

As for the biological monitoring, the program will comprise an initial baseline monitoring to be performed before the beginning of the plant construction works.

Half-yearly campaigns will be performed from the plant start up on, during the two first years, comprising dry and wet seasons of each year. From the third year on, the monitoring campaigns will be performed in a yearly basis, since a good background on seasonal influences will have been built, allowing the interpretation of the results of annual campaigns. These campaigns will be performed the next three years in order to check the occasional occurrence of long-term changes.

6.2.4.3 Responsibility

This monitoring program is a responsibility of the entrepreneur.

6.2.4.4 Costs estimate

Estimated costs for the initial campaign, during the plant construction: R$80.000,00.

Estimated annual cost for the operational step: R$ 50.000,00.

6.2.5 EFFLUENTS MONITORING PROGRAM

6.2.5.1 Objectives and Justifications

Macaé Merchant TPP will be provided with effluents' treatment systems (addressed to both industrial and sanitary effluents), designed in order that the quality of these effluents meet the standards established by the valid legislation, so no change on the water quality of Macaé river is expected.

In order to check the proper operation of these systems while complying with the Program of Self-control for Liquid Effluents of FEEMA (PROCON AGUA) the quality of these effluents must be monitored.

6.2.5.2 Procedures

CECA issued the document DZ-942.R-7; a set of guidelines related to the auto-control program for liquid effluents (PROCON Água), which established criteria and procedures addressed to the auto monitoring of the effluents' quality from potentially or effectively pollutant activities. The following procedures are defined based on these guidelines:

- Samples of the plant effluents (sanitary effluents, effluents from the demineralization plant, blowdown of the cooling tower and combined liquid effluents) will be collected for checking the compliance with the limits established by Resolution CONAMA 20/86 (art. 21) and compared to the conditions verified for the water body downstream the discharge point.
- The effluents' sampling will be performed according to method MF-402.
- The monitoring results will be issued as a report to FEEMA, according to the guidelines considered in the aforementioned DZ.
- This report should include: identification and location of the plant, data on the receiving water body, identification of the treatment system, period comprised by the report, results of the analysis, company that performed the analysis, name and function of the responsible for the report, data on effluents' flow rates, non-complying parameters and measures taken for correcting the problem. The guideline DZ 942 includes a model that must be used for the report
- The treated effluents will be disposed at Macaé river according to Technical Code NT-202 R-10, complying with the standards mentioned at the code.

According to the aforementioned DZ, the monitoring frequency will depend on the effluents flow rate. For Macaé Merchant case, the range between 1,000 and 10,000 m^3/day is the valid one and the associated frequencies are presented next:

Effluents Sampling Frequency

PARAMETERS Flow rate (m^3/day)	FREQUENCY 1.000 through 10.000 m^3/day
pH(1)	Daily
Temperature	Daily
Conductivity	Daily
Chlorides	Weekly
Settleable sediments	Weekly
Total non-filterable residues	Weekly
Volatile, non-filterable residues	Weekly
Dissolved Oxygen	Daily
Oil and grease	Weekly
BOD (affluent/effluent)	Semi-monthly
COD (affluent/effluent)	Weekly
Metals	Weekly
Phenol Index	Weekly
Phenol	Weekly
Sulfides	Weekly
Fluorides	Weekly
Sulfate	Semi-monthly
Surfactant substances	2 times a week
Residual Chlorine	Daily
Ammonium Nitrogen	Weekly
Nitrogen and Nitrite	Weekly
Total Nitrogen	Weekly
Total Phosphorus	Semi-monthly
Toxic Organic Compounds	Semi-monthly
Toxicity	Monthly
Fecal coliforms	Weekly
Minimum number of samples in continuous effluents	8

(1) Control in affluents and effluents

An initial analysis of the effluents generated by the plant will be performed in order to check the need for the analysis of the aforementioned parameters, since some of them should not be affected by the plant operation. In this case, the parameters that turn out to be not present within detectable limits in the plant effluents will be informed to FEEMA and their exclusion from the present program will be decided in agreement with that agency. Nevertheless, these parameters would continue to be monitored within the ambit of Macaé river Water Quality Monitoring Program (program 6.2.4 of this Plan).

6.2.5.3 Responsibility

This program is a responsibility of the entrepreneur.

6.2.5.4 Costs estimate

The total cost estimated for the proposed monitoring activity is R$ 100.000,00/year for the samples analyzed by contracted laboratories, certified by FEEMA, in compliance with PROCON AGUA guidelines.

6.2.6 SOIL AND GROUNDWATER MONITORING PROGRAM

6.2.6.1 Objectives and Justifications

The leakage of oil and other products at the storage areas and workshops could contaminate the soil and the groundwater of these areas. Although these events should not likely occur, considering the agricultural use of the land, previous uses could have left wastes and/or contaminants in the soil or groundwater of the area.

Therefore, the program here proposed aims at controlling and preventing the contamination of the soil and groundwater existing in areas close to storage areas or chemicals handling areas, such as those close to warehouses, water and effluents treatment plants, etc.

6.2.6.2 Procedures

Both the soil and the groundwater of the site will be prospected during the implementation works of the plant, in order to check the existence of contaminants.

The following activities will be performed during these campaigns:

- Drilling of boring holes;
- Measurement of the content of V.O.C.;
- Collection of 4 soil samples from significant spots of the land;
- Collection of 4 groundwater samples from significant spots of the land;
- Analysis of these samples for hydrocarbons, main pollutant metals, VOC, SVOC, polyaromatic hydrocarbons, PAH and PCB.

During the operation step, the soil/groundwater monitoring should follow the same methodology, considering the areas where the following facilities are expected to be located: maintenance workshops and chemicals storage areas. The campaigns must be repeated every 5 years after the plant start-up.

6.2.6.3 Responsibility

This monitoring activity is a responsibility of the entrepreneur.

6.2.6.4 Costs Estimates

The cost estimated for the proposed monitoring is R$ 40.000,00 for the pre-operational campaign and R$ 20.000,00 every 5 years.

6.2.7 EROSION MONITORING PROGRAM

6.2.7.1 Objectives and Justifications

It must be initially highlighted that the restriction N º 5.10 of the LP 013/2001 does not apply to this PBA, since no transmission line is going to be implemented associated to this project, which comprises exclusively an interconnection to the existing system. Nevertheless, the entrepreneur understands that it is necessary to propose and carry out routine prevention measures addressed to the site area. Therefore, the monitoring program here proposed addresses control and remedial measures for erosion processes.

The natural fragility of the soil, associated to human actions, such as land clearing, opening of accesses, earthworks and overall cut-and-fill activities, could affect the soil susceptibility triggering or worsening erosion processes on exposed soils.

Macaé Merchant TPP area is located in a 50-m high hill, with slopes lower than 10º, predominantly composed by red-yellowish latosol, therefore presenting a restrict susceptibility to erosion processes.

Despite these characteristics, prevention measures are justified due to the extent of changes imposed to the natural soil by the interventions required for the project implementation.

6.2.7.2 Procedures

In addition to the erosion control measures that are already part of the earthwork project, the identification of areas subject to erosion processes will be performed by routine visual inspections focusing the project areas, followed by a systematic logging of the observed aspects. Those inspections will be performed in a monthly basis.

If initial erosion processes are identified, the following procedures will be taken in order to stop the progress of those processes and recover the degraded areas:

- Construction of energy-dissipation barriers (palisades) within the eroded area (ravines and gullies) in order to reduce the water velocity. In a subsequent step, the eroded area would be revegetated with gramineous and legumes.
- For sub-surface erosion type, the water infiltration surface will be recovered with arboreous/shrubby vegetation, in order to reduce percolation and sub-surface carrying flows. This type of erosion is also hard to restrain so topographic adjustments or drainage works are usually not enough. The process requires preventing the excessive percolation of the stormwater through the soil surface.

6.2.7.3 Responsibility

This program is a responsibility of the construction contractor up to the final delivery of the works becoming, after that, a direct responsibility of the entrepreneur.

6.2.7.4 Costs

The costs of this program are part of the implementation and maintenance costs of the project.

6.2.7.5 Costs estimate

The costs addressed to erosion control measures depend on the extent and type of these processes, so no estimate can be anticipated here.

6.2.7.6 Timetable

During the whole lifetime of the project.

6.2.8 SOLID WASTES MONITORING PROGRAM

6.2.8.1 Objectives and Justifications

The solid wastes generated by Macaé Merchant TPP are basically originated from the industrial water treatment process and from the sewer treatment plant.

Oily wastes will be also generated at the oil-water separator or as spent lube oils. Garbage from the office and leftovers from the cafeteria will be also produced by the plant operation.

Most of the solid wastes generated by Macaé Merchant TPP are not risk wastes and can be disposed in sanitary landfills (such as common garbage, leftovers, sludge from the sewer treatment plant) or recycled (such as oily wastes, paper, etc.).

Therefore, this program intends to define the criteria to be assumed for monitoring Class II wastes (non-inert wastes, such as the sludge from the sewer treatment), while presenting a solution for their final destination, meeting the Guideline DZ-1311 R4.

6.2.8.2 Procedures

The sludge from the sewer treatment is classified as a non-inert waste (Class II), in accordance with standard NBR 10.004 of ABNT.

As a Class II, these wastes cannot be sent to municipal sanitary landfills and their final destination must be studied and presented to the state environmental control agency, with an analysis of the targeted wastes.

The generation rate of sludge from the water treatment in the plant is estimated in 950 kg/day, which means a weekly removal (about 7 tons) for final destination. Therefore, a weekly sampling must be performed for these wastes, considering the following aspects, as mentioned at DZ-1311:

- Sampler selection – according to NBR 10.007 of ABNT;
- Selection of packages for the samples – polyethylene bags or amber glass flasks can be used for this purpose;
- Sampling point and number of samples – according to NBR 10.007 of ABNT;
- Temporary storage in the plant – the requirements of NB 1.284 of ABNT will be met.

The results of the wastes analysis will be available to the environmental agency for evaluation and opinion.

Those wastes considered as Class II will be sent to a specialized company, properly licensed by FEEMA. Initial contacts have been already performed with the company PLASTIMASSA Industria e Comércio Ltda., located at Adam Blumer Municipal Rd., 5.942, in Magé, which informed to be able to receive those wastes.

6.2.8.3 Responsibility

This monitoring program is a responsibility of the entrepreneur.

6.2.8.4 Costs estimate

The annual cost estimated for this program is R$50.000,00

6.2.8.5 Timetable

This program will start simultaneously to the plant start-up, continuing along the whole lifetime of the project.

6.3 ENVIRONMENTAL OFFSETTING PROGRAMS

The programs presented here aim at the implementation of the offsetting strategies indicated by the Licensing Agency, which are based on the EIA/RIMA studies and on the formal requests submitted to CECA/FEEMA during and after the Public Audience of the project.

In addition to this, the execution of environmental offsetting programs within the ambit of power generation projects, is aligned with the guidelines for the maximization of benefits and regional balance considered by the Environmental Directing Plan of the Brazilian Electrical Sector.

Based on these considerations, the environmental sate agency of Rio de Janeiro, defined that the environmental licensing process of Macaé Merchant TPP must take in account the following environmental offsetting measures, to be taken by the entrepreneur:

- Recomposition of the Marginal Protection Border and recomposition of the riverbeds within the intervention areas, matching these actions to ongoing programs in the project area – “Programa Nossas Árvores”;
- Development of a Handling Plan aiming at extending the studies on the Conservation Unit of the Mangrove of Macaé river estuary;
- Recovery of stretches of the margins of the Coletor channel and Macaé Campos channel, located within the mangrove area of Macaé river estuary, close to Nova Holanda ward, in Macaé city;
- Study on the Hydric Availability of Macaé river Basin, including all affluents up to its mouth at Atlantic Ocean;
- Groundwater survey, comprising the proposal performed by the Mineral Resources Department – DRM of the energy, naval and oil industry secretariat – SEINPE;
- Environmental Education Program, matching the methodology of the government program “Verde que te Quero Verde”, of the state environment secretariat – SEMADS;
- Program of Support to Conservation Units, in compliance with Resolution CONAMA n º 02/96 and Law n º 9985/2000.

At the present step of the licensing process, comprising the request for the Installation License, it is a duty of the entrepreneur submitting to the Licensing Agency all plans, programs and projects addressed to ensure the environmental performance of the project or the fulfillment of the offsetting commitments.

Therefore, and in accordance with the present step of the process, the Environmental Agency determined restrictions that condition the grant of the Installation License to the presentation of the aforementioned offsetting measures by the entrepreneur.

The programs described in this chapter comprise the propositions of the entrepreneur addressed to the accomplishment of those measures.

A summary of the estimated investments, considering the disposals of the valid legislation and the restriction 7 and 8 of the LP 013/2001 is depicted in the next Table:

OFFSETTING PROGRAM	Restriction LP-013/2001	CONAMA 02/96 Value (1000 R$)	Law 9985/00 Value (1000 R$)
6.3.1 Recomposition of Riparian Vegetation	N º 5.15	1.600	
6.3.2 Handling Plan – C.U. Mangrove of Macaé River Mouth	N º 5.16	200	
6.3.3 Recovery of Macaé – Campos Channel	N º 5.17	1.500	
6.3.4 Study on Hydric Availability of Macaé river Basin	N º 5.26	270	
6.3.5 Survey on Groundwater	N º 5.27	180	
6.3.6 Environmental Education Program	N º 5.28	250	
6.3.7 Support to State Conservation Units	N º 5.29		3.000
6.3.8 Support to PARNA of Jurubatiba Coastal Forest	N º 5.30		1.000
TOTAL		**4.000**	**4.000**

6.3.1 PROGRAM OF RECOMPOSITION OF RIPARIAN VEGETATION AND SPRINGS IN MACAÉ RIVER BASIN (RECOVERY OF THE MARGINAL PROTECTION BORDER)

(Meeting Restriction n º 5.15 of LP N º 013/2001)

6.3.1.1 Objectives and Justifications

The objective of this program is providing the reforestation of degraded land stretches of certain areas of the upper and medium Macaé river, by using native species.

The action is justified as an environmental offsetting of Macaé Merchant TPP project, since one of the environmental resources to be used by the project is the water from Macaé river as a consumption material required by the power generation process. IN addition to this resource, it must be also highlighted the utilization of the support capacity of the aerial basin of the area for the dispersion of CO_2 emissions generated by the plant.

This offsetting strategy, while comprising a reforestation action addressed to marginal protection borders of water streams and springs, conduces to the maintenance and preservation of the quality of the water sources of the hydrographic basin while simultaneously provides the collection or carbon from the atmosphere indirectly offsetting the overall impacts related to the emissions of CO2 from the plant, although in a small scale.

In addition to this, considering the forest domain of the Atlantic rainforest where the basins of both the upper and medium Macaé river are located, the reforestation actions here considered match the perspectives of the Project PRÓ-MATA-ATLÂNTICA/RJ, addressed to the protection of Atlantic Rainforest areas in the Serra do Mar. This project has been implemented by the State government in a partnership with the state institute of forest - IEF/RJ with the German cooperation agency KfW. The project considers that, in addition to strengthening conservation units, the recovery and/or the preservation of typical remaining forest formations of the Atlantic rainforest around the conservation units is a fundamental strategy. The Project highlights that the problems to which those ecosystems have been liable to indicate that the integrity of the existing Conservation Units depends on the maintenance and recovery of the natural resources in the surrounding areas. It also considers that these surrounding areas will conduce to the formation of a physical and biological connection between the protected areas and to the long lasting protection of the biodiversity of the Atlantic Rainforest.

Therefore, the proposed reforestation actions, yet addressed to areas external to the conservation units of the region, conduces to the formation of vegetation corridors, whose importance is well-known by the aforementioned state program.

The proposals of this program also match the objectives of the region within the ambit of MRA-5 and, therefore, of the consortium of municipalities that compose this Macro-Environmental Region.

Within this ambit, the Permanent Council of NGO's that is part of the Intermunicipal Consortium has recently proposed a program addressed to the

consolidation of the forest corridors as a strategy for maintaining the integrity of the Atlantic Rainforest ecosystem in the region, aiming at associating this strategy to the perspective of extending and strengthening the regional system of conservation units. The proposal also indicated as one of the priority actions of this strategy the reforestation of riparian vegetation and springs of the basins of the upper and medium Macaé river, As well as stimulating the creation of RPPNs in the region.

At last, it must be highlighted that the proposed actions also match the conservation politics developed by the Environment Secretariat of Macaé, which prioritizes the recovery of degraded areas while making rural landowners of the highlands of the municipality aware of the importance of preserving or recovering the remaining spots of Atlantic Rainforest found in the region. The municipal strategies match those considered by the project PRÓ-MATA-ATLÂNTICA/RJ, since they address the creation or strengthening of municipal conservation units, by means of reforestation actions or by preserving forest corridors that interconnect those units to federal or state conservation units of the region.

The reforestation and recomposition of the riparian vegetation are part of the actions belonging to the municipal program “Nossas Árvores”, whose methodology, developed by SEMA-Macaé, includes involving rural landowners with assisted reforestation programs, providing cuttings, technical assistance and support on planting, supervising and maintaining the reforestation areas.

Therefore, the municipal secretariat formally offered technical support to the entrepreneur teams aiming at a joint action for performing this program, helping on involving local rural landowners and thus ensuring the better effectiveness of the proposed reforestation actions.

6.3.1.2 Procedures

In order to accomplish this program, the following technical and operational procedures will be taken:

- Perform a preliminary analysis of the basin based on recent satellite images and aerial photographs, establishing a first selection of possible reforestation areas;
- Perform and aerial oversight of the basin, especially addressing the pre-selected areas, in order to rank the areas for reforestation purposes;
- Submit the pre-selection and the ranked areas to the analysis of IEF/RJ and of the Environmental Secretariat of Macaé, in order to identify priorities and promote the articulation with other actions of official ongoing programs;

- Define the detailed joint planning with the municipal environmental secretariat so this agency can start the actions addressed to involving rural landowners of the selected areas with the process by means of the mechanisms of the Project Nossa Árvores, (this planning must consider the involvement of representative NGOs of the highlands of Macaé, whose knowledge about the region and its inhabitants will be a valuable instrument to the success of this program);
- Execute the reforestation actions integrated to those related to the project Nossas Árvores in order to interact with the teams of that project while allocating the material resources required for the areas ranked by this program (cuttings and seeds, agricultural implements, logistic resources etc.);

6.3.1.3 Responsibility

The Environmental Supervision Unit of El Paso will be responsible for performing this program, which will be closely related to both IEF/RJ and to the Environmental Secretariat of Macaé.

6.3.1.4 Involved Institutions

Environment Secretariat of Macaé;
IEF/RJ;
Consulting company;
NGOs of MRA-5 that already develop works in the highlands of Macaé.

6.3.1.5 Costs

The cost estimated for this program is R$1.600.000,00 including planning, acquisition of cuttings, agricultural implements and manpower, contracted for one year.

6.3.1.6 Timetable

The program is expected to be fully executed within 1 year.

6.3.2 PROPOSAL OF A HANDLING PLAN FOR THE CONSERVATION UNIT OF THE MANGROVE OF MACAÉ RIVER MOUTH

(Meeting Restriction n º 5.16 of LP N º 013/2001)

6.3.2.1 Objectives and Justifications

Macaé river mouth is characterized by a large mangrove, crossed by a variety of small channels, comprising a relevant environmental resource within the ambit of the biodiversity and environmental quality of the associated ecosystems.

Despite the ecological importance of this ecosystem, the mangrove has been submitted to all sort of degradation pressures, such as land clearing, irregular occupation, illegal fills or pollution by sewerage and wastes disposal from the human settlements that grow around the area.

The remaining mangrove areas are located close to the wards Nova Holanda, Malvinas and Aeroporto, and at the fluvial islands “Colônia Leocádia” and “Caieira”; all these areas associated to the typical ecosystem of Macaé river mouth.

The most preserved stretch of the mangrove is broke into localized spots close to the margins of the drainage channels and at the fluvial islands "Colônia Leocádia" and "Caieira", both close to thew wards Nova Holanda and Malvinas and in the margins of the original bed of Macaé river. These fragments of vegetation still maintain sound conditions for the fauna that depends on them.

The Municipal administration expressly intends to recover these areas, to which resources have been destined in order to remove certain types of occupation and, for the irreversible cases, provide adjacent areas with adequate infrastructure addressed to the environmental preservation of the natural ecosystem associated to them.

Matching this perspective, an offsetting measure was recently defined during the licensing process of another thermal power generation project in Macaé, comprising the development of a handling plan of a conservation unit in Colônia Leocádia island, whose implementation will be performed by the municipal administration within a short term, including the removal of a recent, irregular occupation.

However, the remaining areas require mechanisms addressed to matching their present uses to the preservation requirements of the existing mangrove areas.

Therefore, the Environmental Agency, in compliance with the suggestion of Macaé municipal administration, decided to add to the set of offsetting measures addressed to Macaé Merchant TPP, the extension of the preservation studies for the mangrove of Macaé river mouth including the areas not addressed by the Handling Plan of the Conservation Unit of Colônia Leocádia Island.

The protection and ordination that comprise the objective of this program, should consider the conception of an Environmental protection Areas – APA that comprises the entire area of Macaé river mouth, harmonizing the existent use types to the preservation perspectives addressed to the existing mangrove areas.

The measures is justified for the targeted area since is has been affected by a disordered urban growth resulting from the industrial expansion to which the municipality has been liable to for the last two decades.

This process, basically related to the oil industry activities, has been more recently represented by the implementation of natural gas thermal power plants in the municipality. Therefore, actions addressed to locally offsetting costs and benefits of the federal and state development politics in the region are fully justified for this and pother similar project yet to be licensed in Macaé.

6.3.2.2 Procedures

- Survey on land use and occupation types and vegetal covering within the targeted area by means of overflights and aerial photographs;
- Survey on registers at the municipal administration of Macaé;
- Pre-definition of alternative areas to be integrated to the APA;
- Ecological characterization of the preservation areas;
- Survey on co-localized plans and programs;
- Analysis of the motivation of the population living in the targeted area;
- Development of preliminary proposals for the directing plan;
- Discussion of the proposals with the community;
- Development of an institutional model for the creation and management of the APA;
- Development of the bill addressed to the creation of the APA;
- Development of the Directing Plan.

6.3.2.3 Responsibility

It will be a duty of the entrepreneur contracting a specialized company for developing and accomplishing the aforementioned procedures

6.3.2.4 Involved Institutions

SEMADS
Environment Secretariat of Macaé;
NGOs
Dwellers' associations;
Consulting company

6.3.2.5 Costs

The cost estimated for this program is R$ 200.000,00

6.3.2.6 Timetable

This program should last 6 months from the approval of this proposal and after the Installation License is granted.

6.3.3 PROPOSAL FOR THE RECOVERY OF THE MARGINS OF CHANNELS IN THE MANGROVE AREA OF MACAÉ RIVER MOUTH

(Meeting Restriction n º 5.17 of LP N º 013/2001)

6.3.3.1 Objectives and Justifications

The objective of this program is addressing environmental recovery measures to a 1,000m long stretch of the margin of Canal Coletor, locate within the mangrove area of Macaé river mouth, as well as to a 250-m long stretch of the margin of Macaé-Campos channel. Both targeted stretches are located in Nova Holanda ward and have been destroyed by the advance of riparian habitations upon the bed of both channels, risking the integrity of the water bodies and of the mangroves located across the occupied areas.

Although the area addressed by this measure is located within the targeted area of the Directing Plan of the APA, defined in item 6.3.2 of this document, the intervention here proposed comprises an emergency action addressed to restraining a degradation process which would take to irreversible consequences to the mangrove that is intended to be preserved.

In addition to the preservation of the targeted mangrove areas, this project will also provide a direct intervention of the public administration in the area, by implementing a sewer treatment system along the containment works to be performed at the margins of the referred channels.

6.3.3.2 Procedures

- Preparation of a study and project of recovery measures;
- Presentation of the project to SERLA and FEEMA for approval and environmental licensing, if required;
- Contracting the execution of the containment works;
- Matching the time schedule of the containment works to the time schedule of the government sanitation infrastructure actions.

6.3.3.3 Responsibility

The entrepreneur is responsible for this project and should work in articulation with the Environment Secretariat of Macaé.

6.3.3.4 Involved Institutions

SEMA-Macaé;
FEEMA and SERLA

6.3.3.5 Costs

The cost estimated for this program is R$1.500.000,00

6.3.3.6 Timetable

This program should be performed within 1 year after the approval of this proposal and the grant of the Installation License.

6.3.4 PROPOSAL OF A STUDY ON THE HYDRIC AVAILABILITY OF MACAÉ RIVER BASIN

(Meeting Restriction n º 5.26 of LP N º 013/2001)

6.3.4.1 Objectives and Justifications

This proposal aims at developing studies addressed to increasing the knowledge on the hydric availability of Macaé river basin, where Macaé Merchant TPP will be located.

As presented at the corresponding EIA/RIMA, the available flow-rate of Macaé river is sufficient for supplying the existing consumers in the basin. However, it is a permanent concern of the community that new projects could compromise the water availability and the public supply of future populations.

Therefore, El Paso, as a future consumer of the water resources of Macaé river, attuned to the water uses matter and in compliance to the restriction 5.26 of the LP N^{o} 013/2001, will perform the following studies/activities addressed to the river basin:

- Logging the present water consumers of Macaé river
- Assessing future water demands;
- Study on regionalization of the flow rates, specially for evaluating minimum figures;
- Checking present uses and identifying the existing expectations regarding the future classification of Macaé river;
- Evaluation of the hydric availability.

6.3.4.2 Procedures

These studies will be performed attuned to SERLA, so their results can be integrated to the regional planning basis and within the ambit of the future Water Resources Directing Plan of Macaé river Basin. In order to achieve that, the studies will be preceded by a kick-off meeting with SERLA/FEEMA, when the Working Plan will be presented and discussed, so any specific methodology can be adjusted, if necessary. It is also considered that the involvement of municipalities and communities is fundamental for the aspects of the studies related to the water uses, so the municipal politics and the community needs could become part of the studies. In order to integrate all these participations, the existing Intermunicipal forum is proposed as the articulation media, within the ambit of MRA-5

Logging of users: will contain relevant information for the characterization of the existing uses such as:

- Water supply – Identification of the company, localization of thc water intake - (geographic coordinates); water body; average and maximum flow rates; collection period; capacity; collection type; information on the water transmission, treatment and distribution systems, present supplied population and expansions projections;
- sewerage – effluents disposal, existence of previous effluents treatment; receiving body, disposal area, flow rate; served population
- Industries – identification of the company, location, (geographic coordinates), average and maximum flow rate of water collection, collection period, production type, general information on water transmission and treatment systems; effluents flow rate; effluents quality; projected expansions; status regarding the conformity of the works before SERLA, SLAP and the Granting System.
- Agricultural/Irrigation Users – Identification of responsible properties/companies – name, location, general information; Production/Culture, cultivated area, production; irrigated area and irrigation system, water collection (geographic coordinates); average and maximum water collection flow rates; collection period; capacity; collection projected expansions; status regarding the conformity of the works before SERLA, SLAP and the Granting System.
- Mining – Identification of the company, location, general information; effluents disposal – location (geographic coordinates) if the disposal area, effluents quality, status regarding the conformity of the works before SERLA, SLAP and the Granting System.
- Leisure – Identification; location; type of leisure facility and general information;
- Others – information on all types of water users/uses that could change the fluvial regimen or the characteristics of the ecosystem.

The **evaluation of future water supply demands** will be based on information to be surveyed at CEDAE and the municipalities of the basin, completed with information provided by the census-2000. Based on the surveyed information, projections will be performed addressing both the population growth and the expected service to the municipalities supplied by Macaé river for the next 20 years.

Study on regionalization of flow rates, comprising statistic analysis of the daily flow rates of every hydrologic year at fluviometric stations along Macaé river, as presented at Figure 5.2.6.1 of the EIA (Annex). The data used in the flow rates studies will be obtained at the hydrologic database of DNAEE/ANEEL

In addition to these data, information will be obtained at Norte Fluminense TPP, regarding fluviometric aspects of Severina locality. Norte Fluminense TPP has implemented and operated a Limnonoligc Metering Station since Oct. 2000, where daily measurements of sloping gages are performed and 6 flow-metering campaigns were performed between October/2000 and

March/2001. These information are very interesting for this study, since they allow establishing relationships between the discharges of Upper and Lower Macaé upstream its confluence with São Pedro river.

As part of this proposal, El Paso will perform another set of 6 flow metering campaigns at the same spots where Norte Fluminense TPP has performed its measurements, in order to characterize the dry season and completing a whole hydrologic year for the data on lower Macaé river. These data will be important for the characterization of the actual hydric availability of lower Macaé river, where Macaé Merchant TPP will be implemented and where other significant water users are located.

A graphical representation of the flow rates distribution will be initially prepared, normalized by the mean values of the annual maximum and minimum rates, from which a mean curve will be obtained to be used in the regional study. After the range of annual figures is established, considering a common period between the targeted station, probabilistic distributions will be applied to it, considering those that better match the samples.

Subsequently, another graph will be plotted, displaying the variation of the mean values of extreme maximum and minimum annual rates with the drainage area for the different station considered at the regional study. The obtained adjustment will demonstrate the representativeness of the selected station for the regionalization study.

Check on present uses and identification of the expectations regarding the future classification of Macaé river, which will be based on the initial logging of users, meetings and interviews with all stakeholders, as initially explained. This activity is fundamental for identifying the issues associated to planning the actions regarding Macaé river.

Evaluation of the hydric availability, presented for different interest areas of the basin, relating minimum flow rates to a certain permanence level or to the present uses. A conclusive report will be issued and integrated to the planning basis of SERLA, becoming part of the information required for the future Plan of Macaé River Basin.

6.3.4.3 Responsibility

This program is a responsibility of El Paso and will be performed in articulation with SERLA

6.3.4.4 Costs estimate

The cost estimated for this program is R$270.000,00

6.3.4.5 Timetable

The necessary period required for developing the aforementioned studies, including field activities, is 10 months. It is expected to start this program April/2001 so the completion date would be December /2001.

ENTRA FIGURA 5.2.6.1 DO EIA

6.3.5 SURVEY ON GROUNDWATER WITHIN THE INFLUENCE AREA OF THE PROJECT

(Meeting Restriction n º 5.27 of LP N º 013/2001)

6.3.5.1 Objectives and Justifications

This proposal aims at developing studies addressed to increasing the knowledge on the groundwater availability in Rio de Janeiro state and, most specifically, in, Macaé river basin, where Macaé Merchant TPP will be located..

As presented at the corresponding EIA/RIMA, the available flow-rate of Macaé river is sufficient for supplying the existing consumers in the basin. However, it is a permanent concern of the community that new projects could compromise the water availability and the public supply of future populations.

The underground aquifers are well-known as a truly important water supply source for different uses, but there just a few studies have been performed addressing a safe evaluation of their potential availability, so most of the time these resources are not properly utilized.

Therefore, El Paso, as a future consumer of the water resources of Macaé river and attuned to the water uses matter, will develop a study on groundwater availability comprising a 100 km^2 area at the right margin of Macaé river. The boundaries of the targeted study area will be discussed with DRM-RJ prior to the start of the study, so the obtained results can become an effective part of the State planning on this matter.

The studies will comprise the following main activities:

- Survey on basic data, consistence of the gathered information and development of service thematic charts;

- Logging of water points, identifying their physic characteristics, flow rates, collection aquifers, chemical quality and water uses;

- Survey of the main morpho-tectonic and lithostratigraphic domains in order to define the potentialities of the aquifers and based on photo-interpretation and analysis of digital images;

- Determination of the natural vulnerability of the aquifers regarding contamination processes;

- Determination of the groundwater quality by means of sampling campaigns and analysis of physical, chemical and bacteriological parameters.

6.3.5.2 Procedures

The hydrogeological survey will be based on two main source of data:

- Geological data from existing geological maps of DRM-RJ, supported by cartographic and aerial photogrammetric (aerial photographs and satellite images) provided by that government agency or other institutions;

- Technical data from deep tubular wells drilled in the region (depth, specific flow rate, water level lowering, water quality, etc.). These information will be surveyed at well drilling companies of the State, municipalities and public agencies.

The processes to be taken for characterizing the groundwater will meet the present the international resources used for hydrogeological cartography (IAH - *International Association of Hydrogeologists).* The reach of the registered data and information will comply with the work scale (1:20.000) requiring field services directed only to fitting representative attributes of each domain.

Planning activities and the evaluation of existing data will be initially performed, aimed at indexing all available related data for the targeted region. This activity will comprise initial contacts with related institutions/companies (drilling companies, municipal administrations, sanitation companies, private data and research/teaching institutions); acquisition of information and miscellaneous documents such as drilling reports, photographic material, remote sensing material, geological and hydro-climatological cartographic bases.

A preliminary report will be prepared at the end of this step, comprising a synthesis of the inventoried products, by means of graphs, tables and 1:20.000 service maps, positioning the project for the next steps. This report will also inform the scheduling of the field activities required for gathering supplementary information for the study.

The field surveys will last 12 months, in order to comprise a full hydrologic year. Specific field activities will be performed for areas with no available data or even insufficient data, as indicated by the initial step of the study. This step will outline the hydro-geochemical pattern of the different aquifer types, based on groundwater quality analysis, in order to identify potential contamination focuses.

Simultaneously, the quantitative analysis of the hydrologic/hydrogeologic variables will be similarly performed by monitoring the potenciometric levels of

the spots selected during the first 4 months of this step, also comprising a full hydrologic year. Pumping tests will be performed during the last two months of the campaign in order to provide an estimate on the hydraulic characteristics of the aquifers. After the monitoring completion, the information required for the identification of both quantitative and qualitative patterns of the groundwater should be conclusive and sufficient for understanding their present and futures uses.

After the completion of the field activities, the final thematic maps will be prepared and a final report will be issues, comprising a synthesis of the studies.

A list of the products generated by these studies is presented next:

Intermediate products

- Water Spots Distribution Map – baseline map, where all registered points will be plotted and identified by standardized symbology, including a summary of data for each point according to Annexes B and C (scale 1:20.000);

- Groundwater Quality Map – baseline map, comprising iso-concerntation lies informing the content of different chemicals and indicating pollutant and/or contamination focuses by means of adequate symbology (scale 1 :20.000);

- Map of Fractures' Density – service map, indicating the domain of fractures based on photo-interpretation studies (scale 1:20.000);

- Map of drainages' Density – service map, indicating iso-density domains of drainage lines, based on photo-interpretation studies (scale 1:20.000);

- Slopes Map – service maps, indicating iso-slopes lines of the land (scale 1:20.000).

- Litho-structural map and Geological-Geomorphologic Compartments Map (containing information on unconsolidated covering) – these maps will support the preparation of the two final hydrogeologic charts

Final products

- General log of water spots – hydrogeological database comprising the most important constructive-stratigraphic and hydraulic information for every logged spot;

- hydrogeologic map, indicating potential areas for exploitation of the aquifers – specific flow rates and specific flow rates per penetration meters

will be also delimited, defining low, medium and high potential zones for groundwater exploration purposes.

- Map of Natural Vulnerability of the Aquifers – final product, defined from the data registered from tubular wells. Aspects related to surface alteration and/or recovering materials will be considered, such as permeability and porosity while structural elements of massive rocks, and potential conditions for the dispersion of contaminants in deeper aquifers will be considered for subsurface.

Detailed Activities of the initial step and filed works

Basic data collection, consistence of the acquired information and preparation of working thematic charts

These activities will comprise the development of a specific bibliography, including all available documents filed by the agencies that deal with related issues, cataloging geologic, hydrogeologic/hydrologic and climatic information. The hydric balance of the area should be performed. The information will be treated in order to input a geo-referenced database, continuously updated, allowing the coordination of the main attributes to be used by the project, considering the reliability and consistence degree of these data. This activity includes the consolidation of a working geologic map, with data and interpretations about the structural geology of the whole area. The activity will be part of the first step of the program, performed in the office.

Photo-interpretation studies

These studies aim at understanding the overall morpho-tectonic characteristics of the area by analyzing satellite images, radar and aerial photographs, from which relevant structural elements will be taken within the hydrogeologic ambit of the area, identifying potential for conducting and storing groundwater, emphasizing the crystalline aquifer media and, when applicable, zones of coastal sediments. This is a typical initial office activity, which will be also certainly performed during the intervals between field surveys. Geophysical data, if available for the area, should be also used.

Logging Water Points

This activity will comprise gathering data on different aspects regarding uses, location and hydraulic/constructive characteristics of tubular wells, including listing significant water springs, considering the overall hydrogeological context of the area. This computer-based logging of data will allow the statistic treatment of the main parameters that define the different aquifer typologies, associated to data registered by the companies. All points must be represented by coordinates, checked by a GPS device and altimeters for checking the altimetric level of the selected wells. The list of wells found in the region must include the information presented at ***Annex A.***

Monitoring the Potenciometry of the Aquifers

This activity aims at defining two important characteristics of the aquifers: the first one, related to the variation of the static levels along a full hydrologic year, will allow to determine the annual renewable volume of groundwater (exploitable or regulating reserves), according to the total rainfall indexes of the basin. It will also allow to determine the depth of the static levels of tubular wells, which oscillate according to seasonal climatic characteristics of the region, helping to evaluate the natural vulnerability of the aquifers. The wells monitoring must be performed in a monthly basis, along a full hydrologic year. Piezometers must be installed if no drilled wells are found in the area.

Monitoring of the Groundwater Quality

This activity aims at determining the conductivity, pH and temperature for all wells, "in loco", as well as sampling and analyzing specific parameters of the groundwater for a number of wells selected according to their localization and proximity to potential contamination focuses, including physical-chemical and bacteriological parameters. This survey will allow defining the present contamination status of the aquifers, their potability conditions based on the natural ionic content of the groundwater and their mineralogical characterization, according to their interaction with the wall rocks.

Pumping essays

The results of these tests, even if presenting only localized responses, will provide indication about the hydraulic characteristics of a certain aquifer zone, comprising an auxiliary tool for understanding the hydraulic of homogeneous bodies, when there is a significant distribution through a variety of aquifer domains. Therefore, the amount of essays will be defined according to both the location of the registered wells and photo-interpretation studies. Short-duration tests can be performed for wells when a satisfactory recovery condition is observed, in order to identify significant parameters of the aquifers.

6.3.5.3 Responsibility

This program is a responsibility of El Paso and will be performed in articulation with DRM-RJ.

6.3.5.4 Costs estimate

The total cost estimated for performing this study in the considered 100 km^2 area is R$180.000,00

6.3.5.5 Timetable

The time required for developing the aforementioned studies and activities, including the field surveys, is 18 months. The program should start on June/2001 and its completion is expected for December/2002.

Annex A – Inform, for each well:

I – IDENTIFICATION AND LOCATION

Municipality					
Address					
Owner					
Coordinates N/S	:		E/O		Elevation (m)
Water uses		1. Public supply 2. Industrial / Sanitation 3. Domestic 4. Leisure 5. Irrigation 6. Animal breeding 7. Industrial / Process 8. Other			

II – CONSTRUCTIVE DATA

Drilling company		
Depth:		
Exploration flow rate :		m^3 / h.
Static level :		m.
Dynamic level :		m.
pH :		

Pumping equipment utilized (Type and power)

III - ANNEX:

Well profile

Physical-chemical and bacteriological analysis of the water

IV - REMARKS:

ANNEX B – HYDROGEOLOGIC CHARACTERIZATION

Municipality :

Geology and Hydrogeology:

Aquifer(s) :

Possibility for groundwater collection:

ANNEX C – PROJECT SITE LOCALIZATION DISPLAYING THE GROUNDWATER EXTRACTION POINTS EXISTING IN THE SITE VICINITIES

Reference : Topographic sheet
UTM Coordinates : NS - EW - Keys :
Existing wells in the area Potential pollution sources

6.3.6 ENVIRONMENTAL EDUCATION PROGRAM

(Meeting Restriction n º 5.28 of LP N º 013/2001)

6.3.6.1 Objectives and Justification

The objective of the environmental education program, part of the environmental licensing process of Macaé Merchant TPP, is providing benefits to the needy population living within the influence area of the project.

The development of an Environmental Education Program addressed to the community and related to complex, large projects such as Macaé Merchant TPP, is justified by the fact that the enhancement of the local community awareness about the nature of the proposed activity and about the environmental resources potentially affect by it, enables this community to effectively participate on the management of these resources, aware of the importance of their preservation, including the sustainability of their own dependence to them.

However, this approach has been already and voluntarily taken by the entrepreneur since the first steps of the licensing process of the project, as explained at 6.1.4 in this document, (Social Communication program). This approach has established a direct communication with Macaé community, which has been progressively expanded since the Public Audience, and which will be kept as part of the Social Communication Program.

On the other hand, this education program addresses the social recovery of the needy communities of Macaé by working their environmental perception, not necessarily related to the direct effects of the project.

This program focuses the needy communities of the region of Macaé river mouth, since they are more vulnerable to the socio-environmental changes to which the municipality have been submitted, as a consequence o the industrial expansion related to the development of Campos Basin.

The migration of people to the municipality in search for jobs' opportunities, took to a precarious settling of several families in areas with no sanitation infrastructure and urban services. As a result, these families are liable to poor life quality conditions.

The disordered urban growth and the occupation of environmentally fragile areas by irregular habitation sets or slums are just a few products of this process, which, in a cyclic effect, eventually aggravates even more the life conditions to which these communities are liable to.

In Macaé, wards such as Nova Holanda, Malvinas and Aeroporto, all of them located at the mouth of Macaé river, comprise the most important expression of these social and environmental degradation problems. These communities, traditionally composed by families related to fishing activities, have been suffering strong changes in their social structure along the last two decades,

as a response to the fast growth caused by the migration of people from a variety of origins to the municipality.

The population settlements have been progressively occupying mangrove areas and the flooding basin of Macaé river mouth, making urban services extremely complex and expensive. This scenario takes to communities liable to problems caused by frequent floodings, not served by garbage and sewer collection services ands submitted to precarious salubrity conditions.

The most typical environmental problem faced by these communities is the proximity to the garbage disposed by them into Macaé river. These wastes accumulate along the mangrove areas and around the settlements, being often carried to the river mouth and to the beaches of the vicinities.

The difficulty on finding jobs, that is basically higher for the areas that require specific technical skills, in conjunction with the decay of the fishing activities, have been taking to increasing levels of unemployment or underemployment, which is mirrored by the social degradation, most critically by the lack of perspectives on overcoming these obstacles, faced by the young people of these communities.

The chain of effects here described justify, as a socio-environmental offsetting measure, focusing this program on actions addressed to the social retrieval, most specifically addressed to the young people of the local needy communities.

In a utter analysis, the action is justified by the possibility of making use of Environmental Education tools for building up citizenship conditions, by making the community aware of the cause and effect relationships that relate the environmental degradation to the reduction on its life quality.

Therefore the program here proposed assumes a methodology compatible with the issues of the program “Verde que te Quero Verde”, developed by SEMADS/RJ, which tries to make environmental issues as part of the daily life of young people from needy communities, by identifying and developing subjects directly related to the reality and the needs of these communities.

6.3.6.2 Procedures

The procedures proposed for developing this programs are intended to match the basic methodology of the program “Verde que te quero Verde”, addressing its executive guidelines to the needy communities of the aforementioned wards (Nova Holanda, Malvinas and Aeroporto).

The following procedures will be taken:

- Structuring a working team, composed by retained professionals and local volunteers;

- Training the team on the program methodology, in articulation with the coordination of the program "Verde que te Quero Verde" of SEMADS;
- Identification of dwellers' associations and schools of the needy communities of the targeted wards;
- Divulgation of the lines of the program "Verde que te Quero Verde-Macaé" through these associations and schools and enrollment of youngsters from 16 to 20 years old, formally matriculated in the official schooling network and interested to participate on the program;
- Application of Selection tests addressed to form trainees' groups for environmental agents;
- Enrollment of the approved youngsters to the training program and grant of scholarships;
- Development of a participative diagnosis for defining the qualification content of the program;
- Training and qualification of the youngsters in the activities selected by the diagnosis;
- Establishment of partnerships addressed to the long-term sustainability of the program;
- Assessment of the results.

Based on the knowledge of the entrepreneur during the environmental planning step of the project, a number of local synergy possibilities were identified regarding the approaches of the program methodology.

One of these possibilities would focus the issues regarding the disposal of garbage into Macaé river by the targeted communities, specially regarding PET plastic bottles.

A program linking the environmental awareness of the degrading effects of the wastes disposal to the possible recycling of these wastes as a source of economical advantage for these youngsters and their communities could immediately count on partnerships, able to ensure the long-term sustainability of the program "Verde que te Quero Verde – Macaé". They are:

- Articulation with the municipal administration, addressed to the implementation of a broom's manufacturing unit from PET's bottles. This initiative is previously supported by the interest of the municipal administration in acquiring those brooms for utilization in the urban cleaning system;
- Articulation with the entrepreneur for making available a floating garbage collection equipment for cleaning the river and its mouth, which would become part of the program "Verde que te Quero Verde – Macaé";
- Articulation with other offsetting programs of the entrepreneur addressed to this project, especially those focusing the preservation of the mangrove areas of Macaé river, to which additional opportunities would be created for allocating the environmental agents formed by the "Verde que te Quero Verde – Macaé".

6.3.6.3 Responsibility

El Paso is institutionally responsible for the proposed program, considering its articulation with SEMADS-RJ and the participation of professionals specifically retained for developing this activity.

6.3.6.4 Involved Institutions

SEMADS-RJ;
SEMA-Macaé;
Local NGO's

6.3.6.5 Costs Estimate

The total cost estimated for this program is R$ 250.000,00 , considering the formation and allocation of 40 environmental agents, including scholarships.

6.3.6.6 Timetable

The program will be developed within 10 months from the approval of this proposal and the grant of the Installation License of the project.

6.3.7 PROGRAM OF SUPPORT TO CONSERVATION UNITS

(Meeting Restriction n º 5.29 of LP N º 013/2001)

6.3.7.1 Objectives and Justifications

The objective of this program match the Federal Law 9985/00 addressing environmental offsetting resources to strengthening the protection conservation units of the project PRÓ-MATA-ATLÂNTICA/RJ.

This project, under implementation by the State Government in a partnership with the state forest institute - IEF/RJ and the German cooperation agency KfW, considers the protection of Atlantic Rainforest areas in the Serra do Mar, addressing consolidation actions to Desengano State Park, located in the Macro-Environmental Region 5, where the project site will be localized .

This park is one of the most expressive conservation units of the Atlantic Rainforest in the state, but which purposes has not been easily achieved since the area does not count on any planning mechanisms or even a minimal management infrastructure.

Due to the importance of this unit within for the state and to MRA-5, it is proposed that the offsetting resources addressed by this program are concentrate in this area. The program, though, would be detailed in agreement with IEF/RJ by the time the overall offsetting program of the project starts.

However, considering that Desengano State Park does not present a Directing Plan that could guide its implementation, management and handling, the development of this Plan becomes a priority. Therefore, it is considered here that the scope of this offsetting program comprise the preparation of the Directing Plan, including the implementation of emergency protection measures addressed to the unit, yet to be defined in agreement with IEF/RJ.

In order to achieve this, it is proposed that the entrepreneur makes available an amount of R$3.000.000 as consolidation measures addressed to Desengano State Park.

6.3.7.2 Procedures

The following initial procedures are considered for this program:

- Definition, with IEF/RJ, of the priority investment lines to be assumed for the consolidation of the Unit;
- Structuring the working plan of this program, based on the aforementioned definitions;
- Start of the planned activities, three months after the grant of the installation license;
- Cohering the issues of the implementation to the restrictions of the Operation License by the time this license is granted.

6.3.7.3 Responsibility

El Paso will be responsible for implementing this program, guided by IEF/RJ

6.3.7.4 Involved Institutions

IEF/RJ;
Municipal administration of the municipalities adjacent to the Park (Campos dos Goitacazes, São Fidelis and Santa Maria Madalena);
Board of members of MRA-5

6.3.7.5 Costs estimate

The investment estimated for this program is R$ 3.000.000,00

6.3.7.6 Time Schedule

The program is estimated to be completed within 18 months after its start.

6.3.8 PROGRAM OF SUPPORT TO THE NATIONAL PARK OF JURUBATIBA COASTAL FOREST

(Meeting Restriction n º 5.30 of LP N º 013/2001)

6.3.8.1 Objectives and Justification

Considering the statements of the Previous License of the project, no offsetting would be applicable to the PARNA of Jurubatiba Coastal Forest, since the route of branch of the gas pipeline that will supply Macaé Merchant TPP, is being reviewed by CEG-Rio and should start from a connection to GASDUC (Petrobrás), over 10 km far the aforementioned Conservation Unit.

However, considering the importance of this unit for both the state and MRA-5, the entrepreneur propose voluntarily allocate an amount of R$ 1.000.000, 00 in addressed to the infrastructure of the Park.

6.3.8.2 Procedures

The application of the investments proposed in this program are conditioned to the completion of the Handling Plan of the unit, presently under development. This instrument will assure the adequacy of the actions to be taken, considering the handling purposes of the unit and their specific characteristics. In addition to this, the following procedures are also considered:

- Articulation with the Park administration in order to define the actions to be developed;
- Articulation with the team responsible for the Handling Plan, in order to anticipate goals and objectives of the Pan and define the scope of the investments.

6.3.8.3 Responsibility

El Paso is responsible for implementing this program, in articulation with the Unit administration, to IBAMA (Brasília) and to the Regional Coordination of IBAMA, in Rio de Janeiro.

6.3.8.4 Involved Institutions

IBAMA
Municipal administrations of the adjacent municipalities;
Local NGO's.

6.3.8.5 Costs estimate

The total investment estimated for the program is R$ 1.000.000, 00.

6.3.8.6 Timetable

The time schedule for this program will be defined after the establishment of the actions, according to the Handling Plan of the unit.

7 CONCLUSION

Several impacts were identified during the development of the EIA of Macaé Merchant TPP. In order to mitigate and/or compensate the effects of the negative impacts due to the project implementation, environmental programs were proposed in the EIA and detailed at Chapter 6 of this document.

During the development of the Basic Environmental Program, all restrictions performed by the licensing agency when granting the Previous License of the project were considered and incorporated to the program, except for those addressed to the natural gas distribution pipeline, which does not belong to the scope of this program as previously justified. Also, all engineering projects that are closely related to environmental aspects were further detailed and/or changed in order to incorporate environmental considerations.

Therefore, and considering that the implementation of the programs and projects here detailed, the team that performed this PBA understand that the implementation of Macaé Merchant TPP is environmentally feasible, so the state environmental control agencies should decide or not for authorizing its implementation by granting the Installation License to the project.

8 TECHNICAL TEAM

8.1 ENGINEERING PROJECTS

Name	Profession
Nelson Bustamante	Environmental Engineer
Pedro Akos Litsek	Mechanical Engineer
Nelson Córdoba	Mechanical Engineer
Sérgio Nomura	Electrical Engineer

8.2 ENVIRONMENTAL PROJECTS

Name	Profession	Class Council
Edson Cruz de Sá Coordenador	Civil Engineer	CREA-RJ -31001/D
Carlos Roberto Silveira Fontenelle Bizerril	Biologist	RCRB - 12118/2
Cláudia P. B.de Almeida e Silva	Civil Engineer	RJ-47911/D
Cláudia Dias da Silva	Chemistry	CRQ- 03211-326
Sílvio de Oliveira	Environmental meteorologist	CREA/SP 94.850 / D
Virginia Martins Machado	Civil Engineer	CREA-RJ 52-720/D