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ELECTRICITE DE GUINEE
(« EDG »)

Tombo Thermal Power Plant,
Garafiri, Grandes Chutes, Donkéa &
Banéah Hydroelectric Power Plants

Environmental and social management framework & environmental audit

Final report

Bureau
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BURGÉAP

ENVIRONMENTAL CONSULTANCY

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APPENDICES

ABBREVIATIONS

APER	authority for the environmental & resettlement program
AST	Above ground storage tank
APT	*approvisonnement* (supply point)
BT	*basse tension* (low voltage)
CBK	Compagnie de Bauxite de Kindia
CREST	commercial reorientation of the electricity sector toolkit
ECS	Energie Construction Service
EDG	Electricité de Guinée
EIA	environmental impact assessment
EA	environmental assessment
ENELGUI	Entreprise Nationale d'Electricité de Guinée
PPE	Personal protective equiment
FEM	*fonds pour l'environnement mondial* (World funds for the environment)
HFO	heavy fuel oil
HT	*haute tension* (high voltage)
IF 10	10% of intermediary fuel oil
MT	*moyenne tension* (medium voltage)
SEG	Société des Eaux de Guinée
SEREP	name of a company which manufactured an water treatment system called SEREP (SEREP = Société d'études et de réalisation pour l'environnement et le procédé)
SNE	Société Nationale d'Electricité
SOGEL	Société Guinéenne d'Electricité

Chemical symbols :

SS	suspended solids
Cd	cadmium
CO_2	carbon dioxide
Cu	copper
Hg	mercury
Ni	nickel
NOx	Nitrogen oxides
PCBs	polychlorinated biphenyls
Pb	led
Ppm	part per million
SF6	sulfur hexafluoride
SOx	sulfur oxides
VOC	Volatile organic compounds
Zn	zinc

Executive summary

The Republic of Guinea received financial support from the World Bank in order to improve the operational and commercial efficiency of the electricity production, transmission and distribution assets.

In order to use the funds granted, it was suggested that an environmental and social management framework and an environmental audit are carried out. The Guinean consultancy LAFORET was appointed to carry out those studies.

The thermal power plant of TOMBO located in Conakry, and the hydroelectric power plants of Grandes Chutes, Donkéa et Banéah (see location map in appendix 1) were audited between 27th and 30th December 2005.

A summary of the environmental assessment of these power plants and proposed social and environmental management framework is given below.

➢ Environmental assessment of the power plants

TOMBO thermal power plant :

- Socio-economical impacts (minor issue) :

  The main socio-economical impact associated with the operation of the power plant concerns occupational hazards and the health & safety of people in the vicinity of the plant (fire hazards exist due to the presence of large quantities of hydrocarbons). We would recommend that an estimation of the impacts of a fire on neighbouring populations is carried out.

- Water management (major issue) :

  The issue associated with the management of the plant's wastewater (polluted) can only be solved once the recommendations made in previous studies, in 2003 and 2004 (mainly repairs / replacements of parts / equipments); and personnel's awareness on improving environmental management practices are implemented. These recommendations are summarized below.

  Three environmental studies were carried out over the past three years for the thermal power plant of TOMBO. In 2003, the quality of the plant's wastewaters was evaluated. Analytical results showed that the wastewaters contain elevated concentrations of metals, suspended matter, hydrocarbons, and phenols. The effluents are discharged into a lack or the sea.

  The following recommendations, formulated in 2003, should be implemented :

  - Remediation of the lack ; cleaning and removal of tar / oil deposits ;
  - Installation of a more appropriate collection system (oil separator), construction of an appropriate storage for the wastewater and / or disposal by better means (furnace) ;
  - Prohibition to discharge wastewater into the sea.

  The other two studies carried out in 2003 and 2004 highlighted a highly hazardous environmental situation with regard to the power plant's pollution risks, equipment safety and financial status ; measures to reduce the environmental impacts of the plant were identified; they must be implemented:

  - In the short term :
    - The incinerator and SEREP equipment must be repaired ;
    - Groups 23 & 24G (TOMBO II) and group 16G – NIGATTA – (TOMBO I) must be repaired to stop fuel oil and IF10 leaks ;
    - The provision of a $20m^3$ capacity mobile reservoir to drain the retentions which often overflow ;
    - The mobile SEREP must be repaired.
  - In the medium term :

- The increase of the incinerator's capacity by including a new wastewater collection system and incinerator into the new Tombo 5 project.
- The re-examination of the cleaning contract in order to include the chemical treatment of petroleum products by an accredited dispersant.
- The provision of a specific equipment to remove greenhouse gas from site exhaust fumes.
- The provision of appropriate pumps for the wastewaters' collection system as well as the fuel transport network.

- In the long term : The implementation of a project including technical and financial support from FEM for the management of Tombo's effluents / fumes.

- Management of air emissions (major issue) :

  We would recommend that air quality monitoring be carried out on the gas vents, in order to assess the impact of the groups on the air quality.

- Management of hazardous products (major issue) :

  Many hazardous products are present on the TOMBO site ; however, their management is inadequate or inexistent (lack of retention, leaks, etc.). A such, the issue associated with the management of hazardous products will only be solved once the solutions recommended in the previous studies of 2003 & 2004 are implemented: mainly repair / replacement of parts / equipments, and personnel's awareness on improving environmental management practices, and on the impacts generated by the site.

- Waste management (major issue) :

  The issue associated with waste management is closely linked to the air and water management issues. As such, it cannot be solved until the solutions recommended in the previous studies of 2003 & 2004 are implemented: mainly repair / replacement of parts / equipments, and personnel's awareness on improving environmental management practices, and on the impacts generated by the site.

  En outre, une procédure spécifique à la gestion des déchets devra être mise en place.

- Noise emission levels (major issue) :

  We would recommend that noise emission levels are assessed inside and outside buildings in order to determine the impact of the activities on workers and neighbouring populations.

- Health & safety (minor issue) :

  Some employees must be trained as first-aid worker and follow yearly readjustments.

  Personal protective equipments must be provided to the employees in accordance with the task they have to perform.

  Neighbouring populations must be informed of the potential dangers associated with EDG's activities at the TOMBO site, and of the behaviour to adopt in case of an accident (fire). As such, EDG must implement an adequate procedure.

- Fire protection (minor issue) :

  The power plant must be equipped with fire extinguishers in sufficient quantities; these extinguishers must be checked on an annual basis and a report must be issued. Site personal must be trained to the use of fire extinguishers and follow yearly readjustments.

  Exercises involving the use of fire extinguishers and evacuation exercises must be carried out at regular intervals.

Hydroelectric power plants :

- Social & economical impacts (major issue) :

  Environmental studies were only carried out for the Garafiri site, before the hydroelectric scheme was constructed. However, no environmental monitoring (water, ecosystem) was carried out after the construction was completed.

  Therefore, we can confirm that apart for the Garafiri project, the social and economical impacts of the audited hydropower plants are unknown or not quantified.

  Main social and economical impacts concern the resettlement of populations and the destruction of an ecosystem.

  We would recommend that a study of the environmental impacts associated with the audited hydropower plants and a monitoring of the impacts identified for the Garafiri project.

- Water management (major issue) :

  The issue associated with water management (accidental pollution ; water quality) cannot be solved until :

  - The quality of the abstracted / discharged water has been assessed
    - The impacts have been quantified and the solutions recommended in the 2003 & 2004 studies have been implemented (mainly repairs/ replacement of parts / equipments)
    - Personnel's awareness on improving environmental management practices has been increased
    - Repair of leaking equipments and installation of oil separators

- Management of air emissions (observation) :

  Apart from emissions generated by employees' cars and power backup equipments which work only a few minutes a day, hydroelectric power plants do not generate specific air emissions.

- Management of hazardous products (major issue) :

  Many hazardous products are used in small quantities on each hydro power plant ; however, their management is inadequate or improper. As such, the issue associated with the management of hazardous materials will only be solved once:

  - Appropriate retentions are built
  - Personnel's awareness on improving environmental management practices has been improved
  - Repair of leaking equipments and installation of oil separators

  Furthermore, a specific guideline must be prepared regarding the management of hazardous substances and an inventory of these products must be carried out and regularly updated on each site.

- Waste management (minor issue) :

  There is no management of wastes generated at each power plant, either regarding qualitative aspects or quantitative aspects.

  The issue associated with waste management is closely related to water and air management. As such, this issue will only be solved once the solutions recommended previously are implemented; this includes increasing personnel's awareness on improving environmental management practices.

  Furthemore, a specific procedure regarding waste management must be implemented.

- Noise emission levels (observation) :

  We would recommend that noise emission levels are assessed inside the power plants. Appropriate personal protective equipments (ear plugs) should be provided for the personnel exposed to elevated noise levels.

- Health & safety (major issue) :

  Some employees must be trained as first-aid workers and follow regular readjustments.

  Appropriate personal protective equipments must be provided to the employees in accordance with the work they carry out.

  A specific procedure on how to warn and evacuate populations, who could be affected if the dam failed, should be prepared.

- Fire protection (minor issue) :

  The power plants must be equipped with fire extinguishers in sufficient quantities; these extinguishers must be checked on an annual basis and a report must be issued. Site personal must be trained to the use of fire extinguishers and follow yearly readjustments.

  Exercises involving the use of fire extinguishers and evacuation exercises must be carried out at regular intervals.

  The automatic fire extinguishing systems (sprinklers) must be kept in working conditions.

Energy management (major issue)

The equipments of the power plants are regularly checked. However, due to insufficient funds, parts / equipments are not changed or repaired when needed.

Organisation (observation)

- Environmental department :

  To date, the principles of the Directive from the environmental department have not been implemented, due to lack of treasury. The action plan was only partly implemented : the quality of the wastewater from the thermal power plant of TOMBO was characterised.

- Training department :

  We would recommend that a training program is prepared in collaboration with the environmental department for the aspects requiring specific awareness (waste, hazardous waste, hazardous products).

- Safety & prevention department :

  The safety & prevention department carries out inspections of the facilities and prepares reports highlighting specific needs. These needs should be treated.

➢ Environmental and social management framework

Political, administrative and legislative framework :

Since 1985, Guinea has implemented several environmental and social reforms in order to help its development and protect the environment at the same time.

Guinea's environmental policy is based on the Environmental National Action Plan which facilitates the implementation of a participative policy for sustainable management of natural resources and of the environment.

Guinean Law has considerably improved through the adoption of several by-laws (general or relating to specific matters). Among those by-laws, we can mention the Environmental Code and its associated decrees and ordinances, the Forest Code, the Domain Land Code, and the Water Code which enact the standards regarding two highly important resources: soil and water.

However, gaps remain at two legislative levels: first all basic laws have not been adopted to date, and secondly complementary by-laws must be taken in application of existing laws.

In this context, EDG sites do not have any land property document stating that EDG owns the land it exploits : land property limits are not identified and operating permits have not been issued, although it is required under the Environmental Code and the Water Code. It would be advisable to regularize the situation, so that:

- EDG can implement preventive measures regarding safety of equipments, on their own land;
- Specific requirements are set for EDG's installations, regarding environmental management. However, this administrative authorization cannot reasonably be issued before an impact study has been carried out, as stated in the Environmental Code.

In addition to national environmental codes and regulations, the World Bank's environmental and social safeguarding policies must be taken into consideration.

Operational policy referenced OP 4.01 (environmental assessment) is applicable to the sites' activities. Policies associated with natural habitats (OP 4.04), safety of dams (OP 4.37) and Pest Management (OP 4.09) are also applicable as precautionary measures aimed at reducing impacts to minimum levels. Standards referred to in this report are those into force when writing this report. A new version of the World Bank's policies will be issued later this year (2006).

Brief project description and main impacts identified :

EDG's project is divided into three : i) CREST (Commercial Reorientation of the Electricity Sector Toolkit) in order to improve the distribution network, the quality of the electricity sector, customers' satisfaction, and to reduce the electricity losses; ii) rehabilitation of Garafiri hydroelectric power plant and the thermal power plant of Tombo to increase the electricity output; iii) promotion of better management of energy demands, promotion of private sector involvements (investments; management practices), assistance to EDG to improve their management capabilities (technical and financial).

The project does not involve the construction of a new power plant, but the rehabilitation of the existing hydroelectric and thermal power plants, in order to improve production and distribution of the electricity network. This rehabilitation will aim at the reinforcement of technical installations and will not include any expropriation or new constructions.

The main environmental concerns relate to liquid and solid waste management (used oils, containers, industrial and special waste...), but also management of air emissions, ground contaminations and safety matters (health hazards...).

Based on the size of the project and the nature of potential sub-projects, the location of the project in regions of low environmental sensitivity and the environmental impacts which can be reduced by the implementation of appropriate measures, the project could be classified as a category B project (in accordance with the World Bank policy on environmental assessment (OP 4.01). The evaluation of environmental conditions carried out during the sites' visits shows that the areas directly impacted by the power plants are located near the power plants; the recommended measures will allow to reduce negative impacts.

Proposed code of environmental good practices :

Environmental good practice codes based on the World Bank policies concern :

- The electricity producing plants : both hydroelectric and thermal;
- The dams and the water reservoirs.

Based on the classification of the project, an environmental assessment is required for all installations. Due to the lack of background data, these impact studies will only comprise a detailed environmental audit, mainly including data from the first part of this report (environmental audit of the sites). Investigative works with

associated analyses must be carried out in order to characterize the actual state of the sites, and use these data as background data for future monitoring of the sites. This will allow a better control of the investments carried out to repair the structures.

- Regarding the electricity producing plants :

  The wastes generated by the thermal power plants are typical of combustion units. The main source of pollution concerns air emissions liquid waste (effluents). Regarding hydropower plants, only a appropriate waste management of solid and liquid waste can reduce environmental impacts.

  An environmental management plan must be implemented to ensure that :

  - the thermal power plant is technical enhanced; low sulphur content fuel is used; and that regular monitoring of air quality and air emissions is carried out.
  - Wastes are sorted on all electricity production plants.
  - Cooling waters are treated ; rainwater contaminated with hydrocarbons are managed ; and the quality of the water bodies receiving the wastewaters is checked regularly.
  - The following items are limited : ground pollution by hydrocarbons, health risks due to skin contact with substances.

- Regarding the dam and the reservoirs :
  - Systematic preventive management must be implemented regarding the quality of the water in the reservoirs.
  - Monitoring of reservoirs' sedimentation by means of regulatory controls of silting levels must be undertaken.
  - Monitoring of the aquatic ecosystem in alluvial substrata must be carried out.

1 Purpose of the mission

The Republic of Guinea received financial support from the World Bank in order to improve the operational and commercial efficiency of the electricity production, transmission and distribution assets.

In order to use the funds granted, it was suggested that an environmental and social management framework and an environmental audit are carried out. The Guinean consultancy LAFORET was appointed to carry out those studies.

For clarity reasons, this report presents the environmental audit report first, and then the environmental and social management framework.

The findings of the audit are based on the sites' visits and the interview of EDG's representatives from the environmental department and the engineering department, between 27th and 30th December 2005.

The sites' visits were carried out by Mr Donghol DIALLO and Mrs Véronique ALLPORT who were accompanied by Mr Sékou FOFANA from EDG's environmental department

2 Electricité de Guinée

2.1 Background information

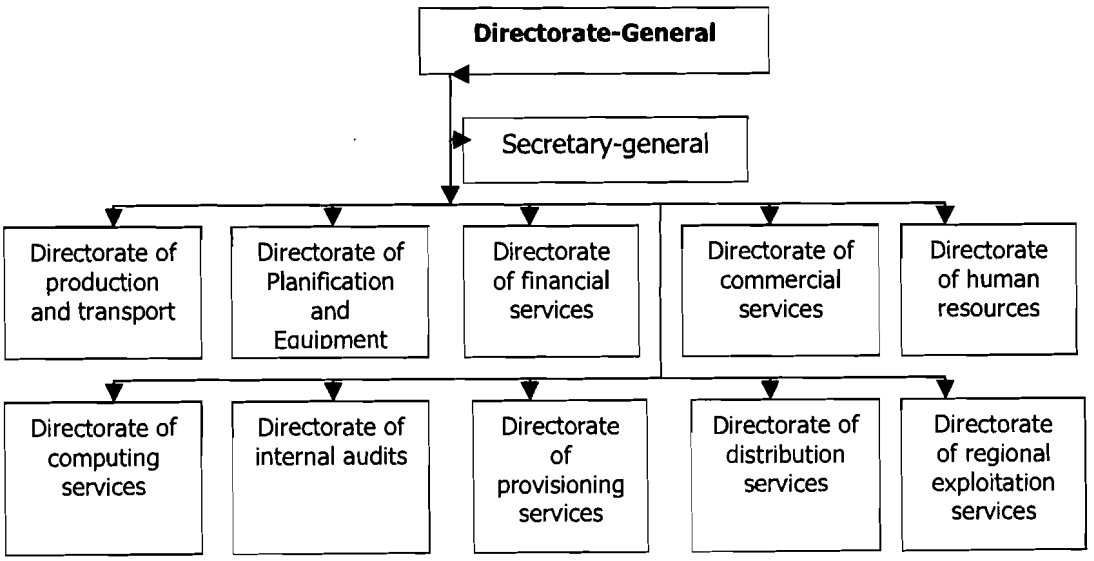
Electricité de Guinée (hereafter referred to as « EDG »), was founded after the dissolution / liquidation of the *Société Guinéenne d'Electricité* (SOGEL) and the dissolution of the *Entreprise Nationale d'Electricité de Guinée* (Enelgui). EDG is therefore the successor of the *Société Nationale d'Electricité* (SNE), the *Entreprise Nationale d'Electricité de Guinée* (national company) and Enelgui (patrimony company).

EDG is a limited company with public participation. The State is the only share-holder. However, its is managed according to commercial laws.

EDG is in charge of the patrimony, the exploitation, the maintenance, the rehabilitation, the renewal and the developmen of the installations and equipments used for electricity production, transport and distribution, in order to provide electricity to the Republic of Guinea. Outside Conakry, EDG exploits 24 districts within the country.

2.2 Organization

EDG comprises 10 branches as shown below.



EDG's internal organisation

Each branch is divided into departments ; for example, the directorate of planification and equipment comprises the following departments :

- Design and planification department
- Equipment department

- Electrification of towns department
- Environmental department
- Programming and cost estimating department
- Documentation department
- General design department
- Department of statistics
- Equipment, production and transport department
- Equipment, distribution department
- Civil engineering department
- Department of contract preparation
- Engineering and construction works department

EDG is a public company whose missions, stated in the environmental policy letter shown in appendix 3, are summarised below:

- the guarantee of a public service for electricity delivery
- the management and the development of the electrical heritage of Guinea
- the exploitation and the distribution of electricity to the entire territory of Guinea.

In order to achieve EDG management policy's objectives, the following actions must be carried out :

1- The distribution networks must be reinstated ; major maintenance works must be carried out ; production equipments from both hydroelectric and thermal power plants must be improved, for the Conakry area, and the Samou-Konkouré river system[1] ;

2- The increase of the production capacity for mainland cities, and the electrification of new cities;

3- The increase of electricity sales by means of new decentralized commercial agencies to improve the rate of invoicing and payment recovery compatible with the increased energy production level.

[1] The thermal and hydroelectric power plants referred to are the five plants audited and described in this report

3 Sites' description

The location of the power plants is shown in appendix 1. The hydroelectric power plants are more precisely located on an aerial photograph shown in appendix 2.

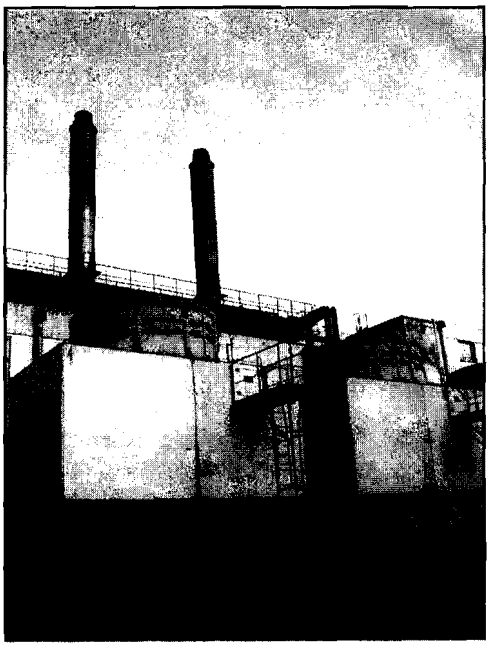
The hydroelectric power plants of Grandes Chutes, Donkéa & Banéah are three power plants « in tandem », the Banéah power plant is the furthest upstream, and the Grandes Chutes power plant is the furthest downstream.

3.1 TOMBO thermal power plant

Location

The thermal power plant of TOMBO is located in the center of Conakry. It comprises 4 sub-stations, either fired by HFO (Heavy Fuel Oil), or by IF10 (10% of intermediary fuel oil) :

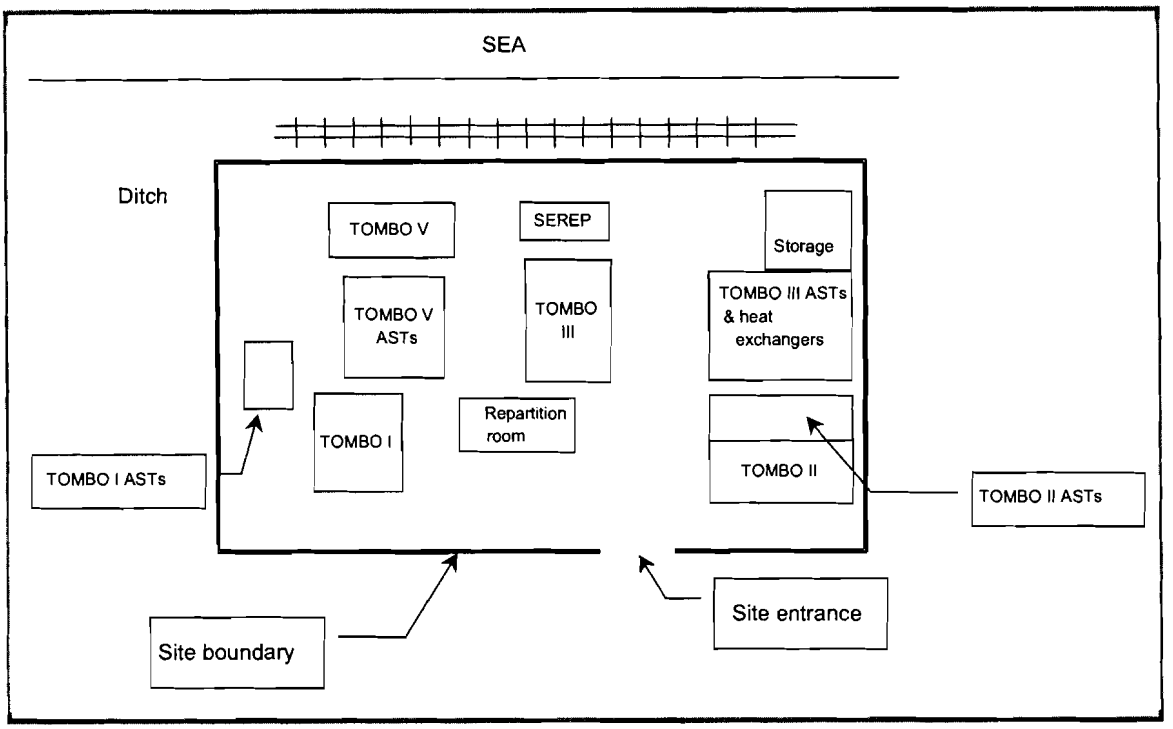
- TOMBO I, installed capacity of 27.5MW, but actually out of order (17.5MW are recoverable) ; it comprises 6 groups (3 can be used) installed in 1982, 1987, 1993 & 1997.
- TOMBO II, installed capacity of 21MW, but actually out of order (10MW are recoverable) ; it comprises 4 groups (1 can be used) installed between 1990 and 1997. EDG confirmed that the ANSALDO engines were inadequate.
- TOMBO III, installed capacity of 45MW, but actually partially out of order (22.5MW could function) ; it comprises 4 groups installed between 1997 and 1999.
- TOMBO IV, installed capacity of 12MW, which corresponds to the recovery of 2.5MW from TOMBO I and 10MW from TOMBO II.
- TOMBO V, installed capacity of 35MW, which is partially functioning (10.8MW in use),which comprises 3 groups installed between 2004 & 2005.



The layout of the sub-stations is shown on the next page.

The thermal power plant of TOMBO is bounded :

- To the north by a railway line and the sea ;
- To the east by garages belonging to the Government;
- To the south by the Northern cornice and the railway line linking Conakry to Niger;
- To the west by a petroleum company.



Note : AST = above ground storage tank

Layout of the thermal power plant of TOMBO (not at scale)

Manpower

The thermal power plant of TOMBO employs 103 people.

Technical description

Each sub-station is equipped with above ground storage tanks :

- HFO tanks - heavy oil – (crude and treated) – capacities of : 2X2000 m^3, 2X 500 m^3, 100 m^3, 55 m^3
- IF10 tanks – fuel - (crude and treated), capacities : 3x100 m^3 (crude), 100 tonnes (treated)
- Daily tanks : 4X24 m^3 et 8X5 m^3
- A water tank (2000m^3)
- A tank for liquid waste (5 tonnes)
- Oil tanks (50m^3 & 16m^3)
- A tank containing used oils (13m^3)

Each sub-station is generally equipped with :

- A control room or a monitoring room where the following parameters are followed for the groups : speed, temperature, levels, pressure, current, tension etc.;
- A storage room for products & materials
- A repair workshop
- A treatment station (SEREP) with an incineration oven for the sludge is present on site, but is actually out of order

- An emergency power supply comprising a diesel engine and above ground diesel tanks (5000L and 400L) ; the emergency unit is used to restart the groups, approximately 5 to 20 minutes at a time.

The quality of the water used for industrial activities is checked and adjusted if needed by chemical treatment, so that the equipments can function properly. The following parameters are checked: pH, total iron, phosphates, nitrites et nitrates.

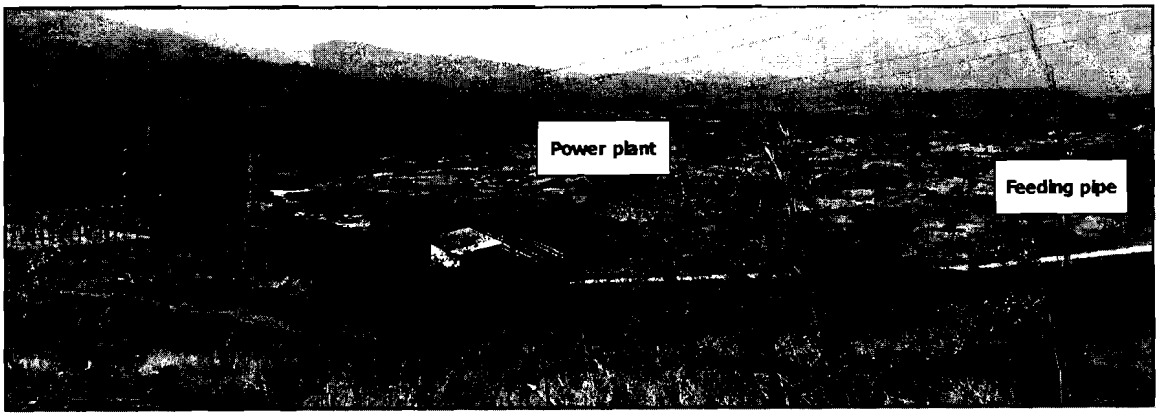
3.2 Grandes Chutes hydropower plant

Location

The hydroelectric power plant of Grandes Chutes is located in the district of Kindia, 100km North-East of Conakry. It has an installed capacity of 27MW.

The hydroelectric power plant of Grandes Chutes was first constructed in 1953 (with 10MW installed); an additional 10MW was installed in 1969; a second phase of construction occurred in 1983 (an additional 7MW was installed). Major leaks were repaired at that time.

The site of Grandes Chutes is located near the listed forest of Grandes Chutes.



View of the hydroelectric power plant of Grandes Chutes and immediate surroundings

Manpower

The power plant employs 18 people.

Dam of Grandes Chutes

Up to 2 million cubic meters of water can be contained with the dam of Grandes Chutes ; 1 million cubic meters are required for the power plant to be able to work.

Technical description

Main characteristics of the dam

Date of construction :	1951-1956
Water course :	Samou
Type of dam :	concrete
Geology :	rock
Maximum height on natural ground :	5m

Total length of dam :	475m
Altitude at top of dam :	242m

Main characteristics of the reservoir

Normal water level :	240,10m
Height of free fall :	120m
Derived flow :	$10m^3/s$
Capacity of reservoir :	$2x10^6m^3$
Catchment area :	$895km^2$
Average flow :	$16m^3/s$
Typical low level flow :	$1,5m^3/s$
Typical rising flow :	$65m^3/s$

Reinforced concrete underground feeding tunnel

Length :	970m
Diameter :	3m
Derived flow :	$20m^3/s$

Metal forced feeding pipes

Length :	2 x 600m
Diameter :	1,80m
Derived flow :	2 x 10 m^3/s

Diaphragm balance chamber

Height :	22m
Diameter :	4m

Production equipments

Since the extension of the power plant, it comprises Francis-type turbines (horizontal axis) : 2 x 5,02MW and 2 x 8,8MW. The site is equipped with an emergency power supply comprising a diesel engine and an above ground diesel tank (5000L). The site also comprises an electricity distribution and transformation center.

It should be noted that Donkéa auxiliary equipments can power the Grandes Chutes equipments in case of a long power cut (for maintenance for example) and vice versa.

EDG confirmed that the alternators' cooling equipments were malfunctioning (leaks). Leaks were also identified at the dilatation joints on the equipments' pipes.

Oil leaks were also detected on the heat exchangers.

3.3 Donkéa hydropower plant

Hydropower plant of Donkéa

Location

The dam of Banéah was built in 1969 and the hydroelectric power plant of Donkéa was constructed between 1983 and 1987 ; this hydroelectric scheme is located in the district of Kindia, 110km North-East of Conakry. Its is fed by the reservoir of Kalé located on the Samou river.

Manpower

The hydroelectric power plants of Donkéa & Banéah employ 22 people.

Dam

The hydroelectric power plant of Donkéa is fed by the reservoir of Kalé, which contains 14 million cubic meters, with a minimum of 9 million cubic meters required for the power plant to operate ; the water flows through an open sky canal (1712m long); the scheme also comprises a balance chamber (above ground pipe), a sluice gate, a feeding pipe (600m long & 2.10m in diameter). Leaks were detected along the canal.

The maximum water level at Kalé is 334m.

After the water has gone through the turbines, its flows to the Grandes Chutes power plant via a pipe.

Leaks (origin unknown) were detected at the Kalé dam.

Technical description

The power plant comprises 2 turbines (Francis type ; vertical axis) : 2 x 7.5MW.

It should be noted that Grandes Chutes auxiliary equipments can power the Donkéa equipments in case of a long power cut (for maintenance for example) and vice versa.

The site also comprises an electricity distribution and transformation center.

The site is equipped with an emergency power supply comprising a diesel engine and an above ground diesel tank (5000L) and a battery room.

Oil leaks were detected on the servo-engines ; this oil gets mixed with leaking cooling waters, and is evacuated into the restitution.

Underground water infiltrations occur inside the power plant, and are regularly pumped out.

3.4 Banéah hydropower plant

Location

The hydropower plant of Banéah is located in the district of Kindia, 115km to the North-East of Conakry. The dam of Banéah was constructed in 1969 on the Samou river; the hydropower plant was built between 1983 and 1987. The purpose of the dam is also to regulate the flow at the dam of Kalé.

It has an installed capacity of 5MW.

The filling of the reservoir required the resettlement of populations.

Banéah hydropower plant

Manpower

The hydroelectric power plants of Donkéa and Banéah employ 22 people.

Dam

The dam of Banéah is located upstream of the dams of Kalé and Grandes Chutes. Its purpose is to regulate the water level at both locations. The water flowing through the turbines is then stored at the Kalé reservoir. The dam of Banéah is close to the power plant, which is fed by a 19m free fall water supply. The normal water level for the Banéah reservoir is 370m.

The Banéah reservoir contains 264 hm^3 of water.

Technical description

The power plant comprises 2 turbines (Francis type ; vertical axis) : 2 x 2.5MW.

The site also comprises an electricity distribution and transformation center.

The site is equipped with an emergency power supply comprising a diesel engine and an above ground diesel tank (5000L).

The sluice gate used for draining the base of the reservoir is not working. It was abandoned due to difficult access. However, the mechanisms are regularly maintained by EDG.

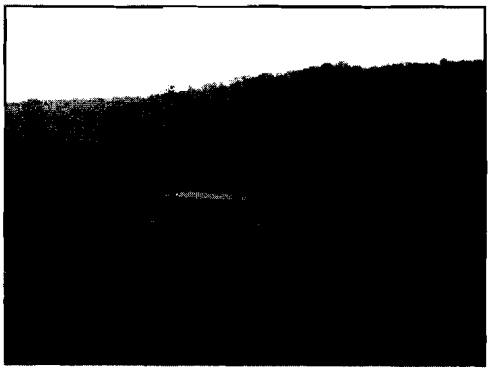
Red deposits and rapid corrosion were observed at the Banéah site.

3.5 Garafiri hydropower plant

Location

The hydroelectric power plant of Garafiri is located in the district of Kindia, 260km North-East of Conakry. The dam of Garafiri and the associated power plant were constructed between 1995 and 2000. The power plant was inaugurated on 5th April 2000. It is fed via a reservoir installed on the Konkouré river.

The Garafiri site is located a few kilometers away from the Balandougou mountain, and the listed forest of Balandougou.



Garafiri hydropower plant

Manpower

The hydropower plant of Garafiri employs 45 people.

Dam

The hydroelectric power plant of Garafiri is fed by the Garafiri reservoir, situated on the Konkouré river; the reservoir contains 1.6 million m^3; the power plant requires a minimum of 1.32 million m^3 to operate.

Technical description (according to the map displayed in appendix 7)

1 – Reservoir, dam & associated structures

Height of dam = 75m

Length = 725m

Width at base = 425m

Volume = 5,2 millions cubic meters of earth

Front and back cover of the dam

Filter and drainage blanket

Lateritic core (fine clay)

Grouting curtain (concrete injection)

2 – Lake

Area = 91km^2

Volume of the lake = 1 600 000 m^3

Minimum volume required for the turbines to work = 1 320 000 m^3

Level of high waters (rising) > 353m

Normal level of the lake (full lake) = 350m

Dead level (plant not operating) = 328m

Water level required for the plant to operate = 22m

Hydroelectric safety load above the mouth of the tunnel = 4m

3 – Intake structures : intake tower : Total height=76m

Height of net = height of the mouth of the tunnel = 19m

Emergency safety gate

Upstream gate

Auxiliary building – gate control device

4 – Feeding structures

Feeding tunnel : L=685m ; diameter = 7,8m

Outflow tunnel : L=605m ; diameter = 5,2m

5 – Plant

Turbines : 3 turbines (Francis-type, vertical axis) : Nominal capacity=26,8MW ; Nominal height=2500mm

Aternator: Nominal capacity=31,5MVA

N=272,7 rounds/minutes; cos(fi)=0,85

The site also comprises an electricity distribution and transformation center, and two emergency power supply groups : an hydraulic group and a power generating unit (a diesel engine and an above ground diesel tank -10m^3-). The site also comprises a battery room.

4 Environmental audit

4.1 Environmental assessment of the TOMBO thermal power plant

4.1.1 Previous studies

Three environmental studies were carried out on the site of the TOMBO power plant during the past three years. A summary and extracts of these studies are provided below.

4.1.1.1 *Etude environnementale des centrales de production thermique de Tombo* (August 2003)

An evaluation of the pollutants present in the wastewaters discharged from Thermal Groups of TOMBO and measures to mitigate their impacts on the ecosystem and on human health was carried out in August 2003 by the *Direction Nationale de l'Environnement – Laboratoire de Contrôle et Expertise en Environnement.*

The aim of this study was mainly to obtain qualitative and quantitative information on the contaminants discharged into the receiving waters, mainly the lake and the sea.

INTRODUCTION

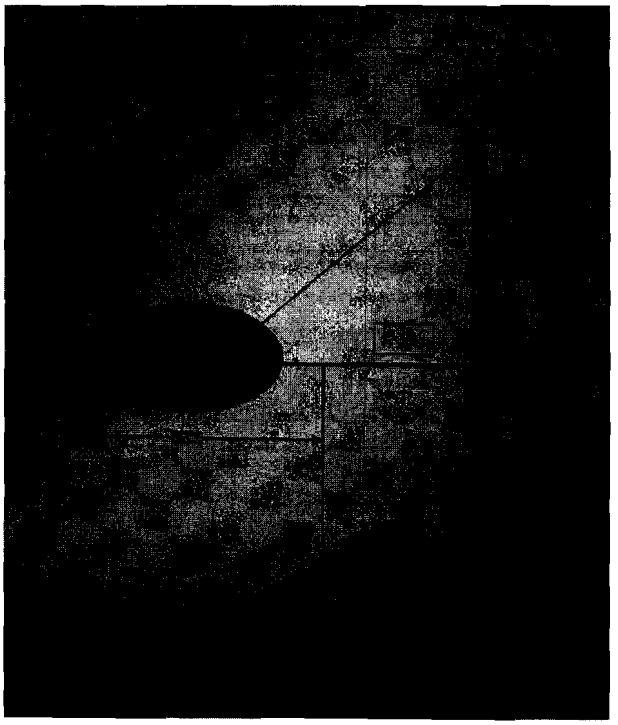
The wastewaters generated by the installations of the TOMBO power plant comprise :

- The wastewaters from cleaning activities, maintenance and lubrification of equipments ;
- Wastes and impurities contained in used oils and fuel oil discharged into the oil separators;
- Cooling waters from the thermal groups.

This effluents are drained from the collectors located on the wastewater sewer network.

The following effluents were sampled : - effluents from the main retention at SEREP, from the main pipe discharging wastewater into the lake / sea. In order to obtain background data to compare the results to, a sea sample was taken further away from the wastewater outlet (in front of Tombo's public school) and a sample of drinking water was also taken. All together a total of 8 water samples were taken :

E-01 : effluents at SEREP
E - 02 : sample taken from the main pipe discharging wastewater into the sea
E - 03: sample of effluents taken from the pipe discharging into the lake
E - 04: water sample taken from the lake
E - 05: point where the waters from the lake are discharged into the sea
E - 06 : point were the waters from the thermal groups are discharged into the sea
E - 00: drinking water
E - Mer : Seawater sample taken away from the plant discharge point (in front of Tombo's public school).



Location of the samples taken from the effluents generated by Tombo's thermal groups

Samples E-01, E-02, E-03, E-04, E-05 & E-06 are heterogeneous and three-phase :

- A black solid superficial layer ;
- An intermediary brown liquid phase;
- A phase of black sedimentary deposits.

pH is alkaline and varies between 8,03 – 10,00 with an elevated turbidity except in sample E - 00.

The electrical conductivity of the samples (i.e. their concentration in dissolved salts) is elevated. A phenol odour was also detected in these samples.

Parameters	E-01	E-02	E-03	E-04	E-05	E-06	E-00	E-Mer
Aspects	Paste like, one phase	3 individual phases (solid – liquid & sedimentary deposit)	3 individual phases (solid – liquid & sedimentary deposit)	3 individual phases (solid – liquid & sedimentary deposit)	2 individual phases (turbid liquid & sedimentary deposit)	2 individual phases (turbid liquid & sedimentary deposit)	One phase	One phase
Colour	PVC black	PVC black Limpid	PVC black Limpid	PVC black Limpid	PVC black grey	PVC black grey	AVC	AVC Turbid
Odour	Strong	Strong	Strong	Medium	Light	Light	AO	Salty
Electrical conductivity ($\mu S/cm^2$)	1863	1780	1420	1370	970	995	550	1200
Turbidity (FTU)	2030	1851	1320	1730	950	905	84	156
pH	10	8.75	8.03	8.25	9.05	9.50	7.75	8.03

Description of the samples of effluents

AVC = absence of visual coloration
AO = absence of odour
PCV = presence of visual coloration

RESULTS

Results of average heavy metal values detected in the superficial solid layer

Sample	Cd (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Hg (ppm)
E-01	12	564	916	2087	64.60	2
E-02	7.1	416	176	1620	71	1.03
E-03	4.34	214	321	331	51	1
E-04	7.87	454	428	2134	182	0.45
E-05	1.08	68	26.3	374	42.7	0.22
E-06	0.9	33	23	525	39.4	0.19

Results of average heavy metals values detected in the layer of sedimentary deposits

Sample	Cd (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Hg (ppm)
E-01						
E-02	10	203	120	243	80.7	0.45
E-03	2	290	129	33	82.3	0.32
E-04	16.68	319	146.65	1703.16	61.7	1.67
E-05	1.7	20.14	13.02	78.35	50.4	1.5
E-06	1.67	11.33	8.33	73.32	53.7	1.23

Results of average heavy metals values detected in the liquid phase

Sample	Cd (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Hg (ppm)
E-01						
E-02	4	80.7	3.91	97.2	32.78	0.09
E-03	0.8	191	4.07	137.2	32.3	0.07
E-04	6.68	128.03	3.52	681.26	24.78	0.33
E-05	0.7	8.07	1.34	31.34	20.14	0.39
E-06	0.67	4.33	1.29	29.33	21.48	0.25

Results of average values of parameters detected in the liquid phase

	Oil / grease (mg/L)	SS (mg/L)	Phenols
E-01			
E-02	150	750	93.28
E-03	175	350	66
E-04	100	125	14.96
E-05	50	80	9.09
E-06	50	75	11.07
E-00	13	10	4.12
E-Mer	19	17	8.04

INTERPRETATION

The interpretation of the results is as follows :

- COD and TOC values as well as phenols concentrations are too high in samples E-02, E-03 & E-04 ;
- Effluents contain elevated concentrations of suspended solids and chlorides ;
- Effluents contain low concentrations of dissolved oxygen ;
- les concentrations en phosphore et en azote total sont élevées.

The following observations can be made :

- an heterogeneous distribution of metals between the three phases ;
- an accumulation of Cd in the lake (E-04) whereas a very low concentration for Cd was detected in the seawater (E-05 et E-06) ;
- an elevated concentration for Cu, Pb & Zn in the solid superficial phase and in the sedimentary phase in all samples ;
- the concentrations for Cu, Cd & Ni in the liquid phase represents approximately 2/5 of the concentration of these pollutants detected in the sedimentary phase ;
- the mercury concentration detected in the liquid phase represents around 1/5 of the concentration detected in the sedimentary layer.

The pollution detected seems to have increased over the past 10 years.

The lake and the ocean (which receive the effluents from the Tombo power plant) are polluted.

The recommendations which were given in the 2003 report are as follows :

- Remediation of the lack ; cleaning and removal of tar / oil deposits ;
- Installation of a more appropriate collection system (oil separator), construction of an appropriate storage for the wastewater and / or disposal by better means (furnace) ;
- Prohibition to discharge wastewater into the sea.

Sludge is actually disposed off by a Chinese company. The other recommended measures have not been implemented to date.

4.1.1.2 *Etude environnementale des centrales de production thermique de Tombo* (September 2003)

Between August 3rd 2003 and August 7th 2003, a environmental assessment mission was carried out by the Directorate of Planification and Equipments on the Tombo power plant.

During the site visit, the mission identified environmental problems generated by Tombo's operations, essentially soil and water pollution of the lake discharging into the sea, due to fuel oil discharge, sludge, oils

and residuary waters. The degree of pollution varied depending on the activities carried out in each area of the plant.

OBSERVATION

Supply point (APT)

The fuel oil is delivered to the groups from the APT through a pressure pipe. A this location, environmental pollution consists of fuel oil leakage when assembling the piston for cleaning the pipe, due to the poor operation of the transfer pumps 028P6A & 028P6B. The fuel oil is collected in a drum and discharged in a canal discharging rain water due to the fact that the mobile SEREP is out of service or due to the absence of a large retention. When it rains, and when the tide is high, this fuel migrates across the whole area of the plant due to rising water levels in the discharge canal which discharges this polluted water into the sea.

Pumping station

The fuel oil and auxiliaries which are common to all groups (such as separators) are stored in this area. Major leaks of fuel oil, collected sludge and heated water can be seen.

It is one of the main polluted zones of the thermal plant of Tombo. The discharge of this mix (heated water, sludge and fuel oil on the ground) spreads across the site ; it is mainly drained by the rain waters towards the lake and then the sea.

The main causes for these discharges are as follows :

- A major leak of heated water on the pipe feeding the separators ;
- The breakdowns of the pumps 036P14 & 036P15 which enable the discharge of the wastewater into the SEREP ; in such conditions, the retention fills up, and is pumped by a tanker due to the unavailability of the mobile SEREP;
- The decayed state of the separators which can treat up to 5000 L/hour which can generate malfunctions of the mechanisms and an overflow of the retention, which can generate fuel oil losses and a major pollution of the local environment;
- The recovery of the scraper causes a significant discharge of fuel oil at the end of the transfer operation of fuel oil of the APT to the TOMBO groups.

Tombo I

This station uses IF10 as fuel. Its separator 027NIB works with a faulty floating pump, as such, the sludge is evacuated towards the sump through the sludge retention. The pump 036P13 from the sump is also out of order. This sump is often full, the transfer is then carried out manually in a skip before being evacuated by cistern. The delays shown by this cistern cause the discharge of this mud in the surrounding environment which then flows towards the lagoon without any treatment through a small underground canal.

Inside the building of Tombo I, the only group working is in a bad state. The body of the machine is dirty. The fuel leaks through holes and joints. The canals which protect the underground installations (Medium voltage cables) are full of fuel. The methods actually used consist of spreading saw dust on the ground.

Outside the building, scrap metal from disused transformers is stored, between the 17V7 reservoir and the IF10 location.

Outside the court, leaks also occur during the refill of the tanks. These oils can be seen along the wall, toward the northern cornice of the plant.

Tombo II

The power station of Tombo II uses fuel oil. Inside the building, the ground is covered with fuel oil. The fuel leaks from the machines through the joints and is discharged across the engine room. The electric cables of the medium voltage cell are covered with fuel oil inside the canal collecting the effluents. The associated floating pumps were out of order; therefore, the evacuation of sump's overflow is done manually or by cistern.

These retentions communicate with a collecting pit which leads to a sump where only two (2) pumps are in operating condition.

Inside the building which shelters the machines, cleaning is defective with fuel leakages occurring through the joints of the groups. Cleaning is carried out by using pieces of clothes or sawdust.

The mud from the sump arrives at the SEREP through a pipe. In addition air pollution is generated by the groups as these are not equipped with greenhouse gas epuration systems. The same can be said from all the groups of Tombo.

SEREP

SEREP is a device which is designed to receive the effluents of all the power stations of Tombo in its collecting basin where the purification operations start. But all the pumps of this station are out of order. The equipment and its accessories are in poor condition.

Because of these breakdowns, the SEREP, which was used to treat the site effluents, does not operate anymore. Its heating device does not function either as the incinerator is also stopped due to a lack of spare parts.

ENVIRONMENTAL PROBLEMS

The environmental problems of Tombo comprise pollution problems encountered at four (4) levels:

1) pollution during the supply of fuel to the power station.

It is done:

a) during the assembly of the scraping piston for the pressure pipe which connects the APT to the power station;
b) by the malfunction of the pumps;
c) during the drainage of excess water from the APT retention, the water-fuel oil mixture is drained to the sea via the rainwater. This process also occurs during high tides;
d) by discharges along the fence of the power station when IF 10 fuel is delivered by trucks.

2) pollution during the groups' operation

a) losses during the drainage of the tanks of the power station
b) losses through the openings and joints of the groups
c) cleaning products: gasoil, sawdust, cloth

3) pollution due to the poor management of wastewater

4) pollution by the power station's cleaning waste

The harmful effects of the Tombo plant, during the delivery of fuel and during site operations, appear on three (3) types of environment:

e) marine environments: the lake and the sea
f) terrestrial environment: the proximity between the power station and its neighbourhoods; as well as the infiltration issues
g) atmospheric emissions: greenhouse gas emission (fumes).

PROPOSAL FOR SOLUTIONS

The following measures for reducing the site impacts were identified by the Planning and Equipment Directorate, according to three main categories:

1 - In the short term, it is vital that the actions hereafter are taken by EDG:

- The repair of the incinerator and the SEREP;
- The repair of the groups 23 and 24G of Tombo 2 and 16 G (NIGATTA) of Tombo 1 in order to stop the losses of fuel oil and IF 10;
- The power station must be equipped with a cistern vehicle specific to the EDG with a capacity of 20 cubic meters necessary for the drainage of sumps which are very often overflowed.
- The repair of the mobile SEREP.

2 – In the medium term, the aim would be:

- To reinforce the capacity of the existing incinerator by potentially installing a new system for collecting the effluents and a new incinerator of bigger capacity at Tombo 5.
- To re-examine the cleaning contract which may be extended to the chemical treatment of petroleum products with the use of a dispersant approved for this purpose; CAMLEN OD 2000.
- To equip the combustion gas exhaust device with a greenhouse gas cleaning facility.
- To equip the effluent collection system adequately.

3 In the long term it will be necessary to envisage:

The implementation of a project of technical and financial support of the FEM for the management of the effluents of the Tombo site.

CONCLUSIONS AND RECOMMENDATIONS

The examination of the environmental problems noted during this evaluation leads us to confirm that the power plant of Tombo is in a very hazardous environmental state in terms of pollution, safety of the installations and economics.

The measures recommended in this study have not been implemented yet.

4.1.1.3 *Etude diagnostic du système de collecte et traitement des effluents de Tombo* (April 2004)

A study of the collecting system and liquid waste processing at TOMBO was carried out by ECS (*Energie Construction & Services*) in April 2004.

It indicates that the effluents generated are evacuated by tankers collected from various points in the power plant. It also shows that the implementation of this system is expensive and that it dirties the power station.

REPORT

TOMBO I

The effluents of the engine 16 G are collected in the pit located at the basement of the engine, and are evacuated regularly by tanker.

The pump initially intended for the transfer of these effluents from the engine pit towards another pit is currently inalienable.

Muds from the centrifugal machines for IF 10 fuel are switched by gravity towards a sump whose pump is also inalienable.

Pump transfer of transformer oil 60/20kV-50MVA

This pump intended to transfer used dielectric oils from the transformer towards the system which processes liquid waste. However, this system is currently inalienable.

TOMBO II and IV

The collection network for the effluents from the two groups of TOMBO IV does not communicate with the network for TOMBO II groups. Thus, the drainage of this circuit is done by tanker.

Additionally, the pump associated with the sump intended for the transfer of the effluents of this zone towards the treatment system is unavailable.

Fuel storage

The purges of the 2000 m^3 storage tank are directly discharged into the sea via a gutter.
Drainage and overflows of these tanks are evacuated by tanker.

Fuel treatment room

Muds generated by 2 double centrifugation modules are not directed any more towards the treatment system because of the unavailability of the 2 pumps envisaged for this purpose. They are currently directed towards the gutters of the room before being evacuated by truck after being collected from the pits located outside the room.

TOMBO III

The drainage pumps of the four oil centrifuges are out of order; muds are directed through pipes and manual valves towards the central drainage system.

The transfer of the collected effluents, towards the treatment system, is carried out by means of two electro pumps laid out in normal/emergency modes and currently operational.

Retaining tank
Daily tanks for TOMBO III

Purges, drainage and overflows of the various tanks, are collected in a sump directly connected to a pit from where they are pumped towards the treatment system. The pump is currently unavailable and is dismounted. This pit also receives the effluents from the cleaning workshop (machine elements).

Liquid waste processing system

The system does not seem to have been used much; therefore, preliminary maintenance should be required for the equipments be work again.

The following points were noted:

- the unavailability of the oil transfer pump towards the muds storage tank which feeds the incinerator,
- problems associated with the valves designed to control the temperature of overheated water, which are not fully water tight,
- lack of dialogue for the diagnosis and the breakdown of the automats in charge of monitoring the system.

Incinerator

The unavailability of this equipment is due to a problem on a dilation compensator on the exhaust circuit.

It was also noted that the electrodes of the burner were burnt and the probes thermocouples which did not function.

TOMBO V

This power group is equipped with a liquid waste collection system which functions like the existing one but is autonomous.

However it should be noted that it is equipped with an oil recovery drum and a continuous inspecting device which monitors the content of hydrocarbons in the treated water before discharge into the sea.

Note: a significant quantity of the spare parts required to maintain the equipment associated with the liquid waste treatment system is missing; in particular the followings are required:

- Spare parts for the electro pumps;
- Spare parts for the incinerator (as the dilatation compensator is out of order);
- Replacements of the valves with three levels of temperature control.

RECOMMENDED SOLUTIONS

The report recommended that:

- the current system for collection of the effluents is maintained and rehabilitated. Regarding the various pumps, they will have to be dismounted in order to determine their actual state and consequently, to draw up a list of spare parts required and pumps to be replaced. Generally, all the purges and the overflows likely to contain hydrocarbon particles, will have to be deviated towards the system of treatment or either towards the sea.
- The entire personnel in charge of the exploitation and the maintenance of the liquid waste treatment system is treated in a suitable and adequate manner.

These measures have not been implemented to date.

4.1.2 Socio-economical aspects

The main socio-economic impact associated with the operation of the power station concerns the risk of accident and the safety and health risks for the public (moreover, because of the presence of hydrocarbons on the site, the fire hazards are significant).

The electricity transmission pylons and lines also present a risk for the public: electrocution or injury caused by the fall of power lines / pylons, or by poor signalling of the pylons.

In the event of a fire, because of the proximity of the neighbouring populations, they could be affected.

4.1.3 Landscape

No particular measures were taken to integrate the power plant into its environment (landscape etc.).

No particular issues were raised.

4.1.4 Water management

4.1.4.1 Water for human consumption

The water used for human consumption on the site comes from the town's water distribution network.

4.1.4.2 Industrial water

The water used for industrial activities on site comes from the town's water distribution network. It is used in an open circuit for the cooling of the equipments and the washing of the floors. The power station currently consumes 10500m^3 / month (to be noted that it does not operate at full capacity).

There is an automatic control system for the "muds" in the effluents before they are discharged. However, according to the former studies carried out on the site, it appears that this system is not operational.

4.1.4.3 Rain water and surface water collection system

The site is equipped with a rain water & surface water collection system. This water is discharged into a ditch connected to the sea. It was noted at the time of the site visit that waters from the collecting system (a ditch with open sky) was soiled by hydrocarbons.

4.1.4.4 Liquid effluents

The the liquid waste treatment station - SEREP - (which must separate water from oil by flotation) is out of service at the present time. The collected effluents are evacuated by a Chinese company (CHEN).

Oily water is collected in pits, then pumped towards a surge tank for oily water before being evacuated. However, based on the former studies, it seems that this system does not function correctly.

If the SEREP was operating properly, this oily water would be treated there, and the muds would be recovered in a specific tank before being incinerated.

4.1.4.5 Water quality

The quality of the water from the town's network is controlled regularly for specific parameters associated with the operation of the equipment (pH, phosphates, nitrites and nitrates).

A specific study of the effluents discharged was carried out previously. It shows that the effluents contain elevated concentrations of phenols, metals, suspended solids.

No sampling or analyses were carried out within the framework of this audit.

The issues associated with water management will only be solved once the solutions recommended in the former studies of 2003 and 2004 (mainly repair/replacement of parts/equipments) are implemented, and site personnel's awareness on better environmental management is increased.

4.1.5 Management of air emissions

Each group of the sub-stations is equipped with a specific exhaust pipe for combustion gases. There are thus 17 of them on the site.

The exhaust fumes of the groups are likely to contain various compounds such as NOx, SOx, dust, polyaromatic hydrocarbons etc. However, the quality of exhaust fumes was not evaluated.

Initially, we would recommend the quality of the air emissions at exit of the exhaust pipes to be evaluated, in order to assess the impact of the groups on the air quality.

4.1.6 Management of hazardous products

4.1.6.1 Hazardous substances

The hazardous substances stored on site consist of:

- Tanks of HFO (crude and treated) – associated capacities: 2000 tons, 500 tons, 100 tons, 55 tons and 24 tons
- Tanks of IF10 (and treated gross), including 3 tanks containing 100 tons of crude oil, and 1 tank containing 100 tons of treated oil
- Daily tanks for the groups (20 tons/unit)
- Tanks for the diesel groups (5000 liters)
- Tank for the effluents (5 tons)
- New oil tanks ($50m^3$ and $16m^3$)
- Used oil tank ($13m^3$)

The tanks are generally, but not systematically, on retention. Many leaks occurred on these equipments. Moreover, regarding the heat exchangers, no system was implemented to avoid the pollution of the ground due to the operation of the pumps (see photography attached).

4.1.6.2 Storage room: specific issues

The room is a not ventilated room where are stored inert materials as well as new or out-of-date chemicals in small quantities. The presence of new or out-of-date pharmaceutical products and some asbestos sheets was noted.

The person in charge of the store does not know how to manage the out-of-date products.

4.1.6.3 Transformers

The site is equipped with several transformers containing oil which are not placed on retention. EDG does not know if these oils contain PCBs. A characterization campaign is in hand.

4.1.6.4 SF6

The circuit breakers of the groups contain SF6 (sulphur hexafluoride). The SF6 is a greenhouse gas (its PRG compared to CO2 is 23900). The equipment must be managed in an adequate manner in order to avoid SF6 discharge to the atmosphere.

4.1.6.5 Asbestos

The personnel of EDG confirmed that they were not aware of the presence of asbestos in building materials at the power station.

Many hazardous products are present on the TOMBO site; however, their management is inadequate or non-existent. Thus, the problems related to the management of the hazardous products will only be solved once the solutions recommended in the former studies of 2003 and 2004 (mainly repair/replacement of parts/equipments) are implemented, and personnel's awareness is improved regarding better environmental management and impacts generated by the site.

4.1.7 Waste management

The liquid waste treatment station SEREP (which was designed to separate water and oil) is out of service at the present time. The recovered effluents are evacuated by a Chinese company (CHEN). Depending on the site activities, recovery is carried out several times per day, or several days apart.

A maximum of $15m^3$ of water mixed with oil is evacuated every day.

The soiled cloths are stored and evacuated by the urban services of Conakry as ordinary waste.

The issues associated with waste management are closely related to the issues associated with water and air management. Thus, these issues will only be solved once the solutions recommended in the former studies of 2003 and 2004 (mainly repair/replacement of parts/equipments) are implemented, and personnel's awareness on better environmental management is improved.
Moreover, a specific procedure on waste management should be prepared.

4.1.8 Pollutions observed

At the time of the site visit, it was noted that leaks had occurred on various equipments in particular near the heat exchangers.

In addition, the water evacuated by the rain water network is polluted with hydrocarbons.

Finally, the quality of the effluents generated by the power station was evaluated in 2003 and indicates the presence of heavy metals and hydrocarbons. It is also mentioned that the quality of the effluents worsened since 1991.

As long as the solutions recommended in the former studies of 2003 and 2004 (mainly repair/replacement of the parts/equipment) and adapted awareness / training are not implemented, the risks of pollution of the environment will continue to exist.

4.1.9 Noise levels

When operating, the groups are generating noise harmful effects. At the time of the site visit, few groups were functioning. At TOMBO V (built in 2005), the buildings were built in accordance with the code of practice and equipped with noise insulating walls.

No measurements of noise levels were carried out to date.

We would recommend the monitoring of noise emission levels inside and outside the buildings in order to determine the impact of the activities on site personnel and nearby populations.

4.1.10 Health & safety

4.1.10.1 Health services

There is no infirmary on the sites. However, the power stations are equipped with first aid kits, and health services are located close to the sites (hospital, etc.).

It should be noted that there are no first-aid workers on the sites.

4.1.10.2 Inventory of accidents

EDG a confirmé qu'aucun accident majeur (incendie, déversement accidentel) ne s'est produit sur le site depuis sa mise en service.

4.1.10.3 Access

The access to the power station is controlled 24h/24h. A masonry wall / fence is located at the site boundary.

4.1.10.4 Maintenance

Regular inspections (daily, weekly, quarterly, semi-annually or annually) are carried out at the power stations by the personnel of the power stations.

A specific list of equipments to be monitored was established for the TOMBO power plant; it indicates the type of controls to be carried out; the following equipment is checked regular:

- Centrifugal machines
- Compressors
- Filters engines
- Auxiliaries (pumps)
- Storage tanks
- Emergency groups

- Heat exchangers
- Heat recovery systems
- Combustion gas treatment
- Transformers
- Overhead travelling cranes
- Other auxiliaries (SEREP, incinerator)
- Electrical power boxes

4.1.10.5 Personal protective equipments

The requirements regarding personal protective equipments (PPE) are transmitted to the direction of EDG by the Prevention department. However, for financial reasons, the required equipments were not provided.

A few ear-protection headsets and gloves are present at the TOMBO site.

4.1.10.6 Emergency response in case of an accident

There is an instruction relating to the action to be taken in the event of an accident which was implemented by the Safety department.

However, no specific procedure is planned for the information of the close populations.

Employees must be trained as rescuer/first-aid workers and have regular recycling.
Adapted PPE must be provided to the employees according to the tasks they carry out.

The nearby populations must be informed of the dangers related to the activities of the TOMBO site, and know how to react in the event of major accident (fire). Thus, EDG must set up an adequate procedure.

4.1.11 Complaints

EDG is not aware of complaints from nearby populations regarding the power station. EDG on the other hand raised concerns regarding the oil company located the vicinity of the site as it asserted the property of specific lands.

4.1.12 Fire protection

Fire protection on site is ensured by fire extinguishers laid out in various locations, and fire hydrants located in the vicinity of the site. However, the number of fire extinguishers seems insufficient.

In addition, the fire brigade is located near the site.

Some installations are also equipped with smoke detectors with transfer to the control room.

The fire extinguishers must be in sufficient quantities, and checked annually (a written document must be issued). The personnel must be trained to the use of fire extinguishers and follow regular recycling.

Exercises on fire extinguishers handling method and on site evacuation must be carried out regularly.

4.2 Environmental assessment of the hydroelectric power plants

4.2.1 Previous studies

Except for the Garafiri site, no specific measures were implemented to integrate the power plants into their surrounding environment (landscape, afforestation etc.).

Environmental studies were only carried out for Garafiri as required by the investors. However, EDG confirmed that no environmental monitoring had been carried out at Gararfiri (water, ecosystem) since the completion of the works.

Conclusions and extracts of the studies carried out prior to the construction of the installation on the Konkouré river are detailed below.

A preliminary study for the Garafiri site entitled *Environnement et Réinstallation des populations* was carried out in 1990 by BCEOM. It described the fields which were going to be affected by the project (water, fauna, flora etc).

In 1993, an environmental study of the Garafiri project was carried out by BCEOM. It recommended that a resettlement program is implemented. The environmental impacts identified by the impact study of 1993 are synthesized in the paragraphs follow.

In 2003, an study of the impact of the hydroelectric installation on the estuary and the catchment area was carried out by IRD-BCEOM-BRLi. The conclusions and extracts of this study are provided hereafter.

4.2.1.1 Garafiri project - Impact study (1993)

The environmental impacts identified by the impact study of 1993 are synthesized in a table which is shown in appendix 9. The impacts concern:

- Water resource and the quality of water (modification of downstream flows)
- Land (area of 8800ha flooded in the valley of Konkouré)
- Ecosystems
    - Vegetation (forest gallery and Guinean savanna on the slopes under water)
    - Fauna (disappearance of the riverain fauna)
- Population and socio-cultural environment
    - The population (299 households to be moved or receive compensation)
    - Water points (adjustment of sources)
    - Education (construction of schools)
    - Health (risk of development of paludism and the bilharziose)
- Roads and tracks (crossing of the ford)
- Fishing (significant development of fishing)
- Tourism (possible touristy activities in Fouta Djalon)

MAIN ENVIRONMENTAL IMPACTS (extract from the impact study of 1993)

Positive impacts

Regularization of downstream flows

A monthly contributions before the dam was built was 69,9 m^3/s/year with a maximum of 263,2 m^3/s in August and a minimum of 1,4 m^3/s in April-May. With the dam, the restored flows will be on average 68,4 m^3/s/year (the difference with the previous situation being due to evaporation of the waters contained in the reservoir), with a peak output of 149,8 m^3/s in September and a minimum flow of 50 m^3/s from December to June.

This improvement of the flows between December and June will allow a better flow near the river and a better water supply to the wells.

Energy production

The capacity of 264 GWH/year is relatively significant compared to the flooded surface of the reservoir (88 km^2); this is representative of an "embedded" reservoir; the project represents an added value at national level that no other project would be able to provide.

Halieutic potential of the reservoir

With an average volume of 1.158 hm^3 and an average surface of 73,4 km^2 the reservoir of Garafiri has a significant halieutic potential (450 T of fish/year).

Negative impacts

Geo-pedological impact

The volume of the dam is 4,5 millions m^3 which will be taken on the upstream part. The catchment area will reach a hundred hectares including 40 located above the average level of the water. The risks of erosion will be rather strong on this zone if preventive measures are not taken.

The solid contributions were estimated at 370.000 m^3 / year which in the long term does not represent a danger to the reservoir in so far as the current situation on the catchment area is not degraded.

Hydrological impact

It was noted that the flows during dry seasons will be notably modified downstream of the dam on approximately 50 km i.e. until the junction with Kakrima and that changes in flows may occur during the day. It will thus be advisable to envisage to inform the downstream bordering populations.

Impacts on the natural ecosystems

- *natural Vegetation*

The reservoir will induce the flooding of 7.500 hectares of Guinean savanna and 150 ha of forest.

The volume of wood located in easily flooded zone is estimated at 190.000 steres, but a part could be recovered in the form of charcoal to cover at least the needs from the populations during the construction of the dam.

There are no species of particular floristic interest in the future flooded zone.

Although the disappearance of the natural environments amounts to thousands of hectares, this represents only one negligible part of the ecosystems of the same type in this area of Guinea.

- *wild Fauna*

The impact on the invertebrates will be particularly significant on all flooded areas.

The birds and the majority of the mammals will have time to take shelter, but these resettled populations will have to fight against the settlements of autochtones for the conquest of territories.

With regard to fauna associated with the cultures, the impact will be limited as cultivated areas will be reconstructed near the old sites.

It is necessary to point out that drowned surfaces represent only 3,5 % of the catchment area.

The populations of chimpanzees were identified beyond the zone of the reservoir, between Dalaba and Koba, more than 20 km away from the future storage reservoir, as for the Balandougou mountains, chimpanzees were not identified there.

Socio-economical impact

It is without any doubt the most significant impact of the dam. In 1993, A total of 25 villages were concerned with 2.429 people. Some of these 25 villages will be moved entirely or partly, which represents 1.716 people and 322 households.

Parallel to the resettlement of the populations, it will be necessary to rebuild 376 large dwellings and 319 small dwellings.

Impact on health

Upstream of the dam black flies will be drowned. The multiplication of molluscs is likely to increase, and at the same time, the development of schistosomiasis.

Downstream on the contrary, maintaining flows will encourage the development of black flies, therefore of onchocerciasis.

Effects of the project on female population

Women represent more than 50 % of the population concerned; they thus ensure a significant proportion of the labour. The women take part in all the agricultural activities and moreover ensure the domestic tasks in particular the supply of water and firewood.

Any improvement consisting in making the supply of water safe, will appreciably decrease the tasks of women in this particular field.

Impacts of associated equipment

Access

The service tracks to access fish unloading areas of the points of unloading of fishing are located on *bowé* and there will be no particular incidence on their design.

The connecting tracks use the layout of existing tracks while improving them; in-situ surveys showed that there was no major impact on the surrounding physical environment, but the maintenance of these tracks will have to be ensured to avoid their degradation.
It should be noted that the tracks and unloading docks were initially programmed but were not carried out due to a lack of funds.

Power lines

The main constraints concern ground occupation and landscape insertion.

The layout was adopted by respecting classified forests; only the forest of Kakoulima close to Sonfonia will be affected on 3 km.

Power lines pass over some dwellings however this could not be avoided in particular at Matoto. It is estimated that about fifty dwellings / houses will have to be moved.

ATTENUATION MEASURES (extract from the impact study of 1993)

Ground conservation

An anti-erosion treatment will be implemented for specific areas.

Protection of natural environments

The installation of a special brigade monitoring and the implementation of support missions should help to respect the existing forest and to limit the pressure from hunters, more particularly for the period of construction of the dam which will see a significant concentration of population on the site, nearly 2.000 people. The associated costs were estimated at 350.460.000 GNF.

Displacements of dwellings related to the power line

About fifty houses will be rebuilt for an estimated amount of 200.000.000 GNF.

Development of fishing activities

Measures to improve the fish potential and to monitor catches from the reservoir will help to maintain an annual production of 450 T of fish. Training activities for the fishermen and the creation of a fishing center with a laboratory are considered. The cost associated for an 8-year period is 1.121.720.000 GNF with 2.400.000 GNF/year of recurring costs for the Fishing Ministry.

Resettlement of populations

It will include the resettlement of moved populations (551.000.000 GNF), a support for the reconstruction of the dwellings, the use of improved seeds and the distribution of fruit trees; for a total of 172.140.000 GNF.

The total amount for compensation for the loss of fruit trees (flooded) is 113.417.000 GNF.

Measures related to education and health

Construction of two schools at a cost of 48.000.000 GNF. Construction of a medical center with Hafia Kokou, construction of a health center at Sangoyah and maintenance of the health center of Garafiri after the construction of the dam and supply of the medical items; the total amount for these measures is 180.345.000 GNF with a recurring cost of 20.492.000 GNF/an for the Health Ministry.

Service tracks

The tracks include the access tracks to the fish unloading centers, and the tracks for the Dalaba-Kakori connection in Bowé-Hafia Kokou. The re-establishment of the Sangoyah-Kakori connection will require the installation of a boat in the village of Koyombo. The cost of these investments is 1.752.000.000 GNF.

Water point adjustments

The construction of water points in the areas of resettlement and in existing villages will concern the installation of sources or wells. The total cost for this program (including preliminary studies) is 297.300.000 GNF.

Tourism

A tourist center can be envisaged on the left bank, it could develop fishing activities on the lake, hunting and excursions. The estimated associated investment is 183.000.000 GNF.

PROVISIONS FOR ENVIRONMENTAL MONITORING (extract from the impact study of 1993)

For the implementation and coordination of the proposed compensatory actions, it is suggested that an Authority is set up for the environmental resettlement program of Garafiri (APER-Gararfiri). The 4 missions that are entrusted to this Authority are:

- Protection and Management of the Environment
- Equipment and work
- Resettlement of the populations
- Administration and accountancy for compensations

Linsam was suggested as the site location for the Authority.

CONCLUSIONS

The main issues raised by the construction of the dam of Garafiri concern primarily the populations to be moved and resettled on the circumference of the storage reservoir.

The impact on the physical environment is relatively small; the part of the ecosystem that will be destroyed is not likely to damage the balance of the ecosystem in the area.

The disadvantages brought by the construction of the dam cannot be compared with the advantages from the production of electrical energy; and the costs of the compensatory measures which are recapitulated in the table hereafter are not able to call into question the profitability of the project.

No monitoring was carried out after the resettlement of the populations. However, it seems that those populations are not satisfied with the measures taken for their new homes.

4.2.1.2 Impact study of 2003

An impact study of the dam of Garafiri on the estuary and the catchment area of Konkouré was carried out by IRD-BCEOM-BRLi in 2003.

The main results of the study are summarized hereafter.

- Continental water run-off and solid transport
  - Continental water run-off
    - The 11 limnimetric stations were calibrated. Their calibrations show that the stations were established with the level of relatively stable sections (except the limnimetric station K01 of Konkouré with Linsan).
    - Sequences of reliable and complete flows are available on practically all stations between 1998 and 2002.
    - On the level of the limnimetric stations no major evolution of the beds could be noted. However, the brutal and frequent resumptions of operation (# 25 with # 100 m3/s) of the power station of Garafiri, probably modify the minor bed of Konkouré downstream from the dam. Note: the hunting phenomenon can present a danger to the residents.
    - On the section of Konkouré ranging between the dam of Garafiri and the junction of Konkouré and Kakrima:
      - The complete stop of the flows between April 1999 and September 1999 probably had an impact on the watery life during the stage (April and May) but for a limited period.
      - The frequent stops of exploitation (flow = 0 m^3/s) must have consequences on the water ecosystem in period of low water level.
    - Water floods are limited on the Konkouré river, between the dam of Garafiri and the junction of Konkouré and Kakrima.
    - In rain season (July to November) the modifications due to the presence of the dam of Garafiri on the natural flows are limited (or absent) perceptible on Konkouré downstream from the junction with Kakrima because of the interannual irregularity.
    - In dry season, the flows are much higher than the natural flows from Garafiri to the estuary of Konkouré. With the low water level, the additional fresh water contribution on the estuary of Konkouré is thus particularly significant.
  - Solid transport in suspension
    - The suspended solid concentrations (SS) measured are low at all the stations including during the rain season (average annual ranging between 6 mg/L and 10 mg/L). The observations made at the K09-b station show concentrations relatively higher due to the vicinity of dam's evacuation channel with muds from the Fria development.
    - The concentrations of SS measured in the Garafiri reservoir (Lg10-j stations, Lg35-j and Lg50-j) are particularly low (less than 2 mg/L). The highest concentrations observed generally correspond to samples taken at greater depth. This apparent increase in the concentrations would be due to the fast precipitation of the Iron dissolved in contact with the air.
    - The concentrations of SS measured on the K04-a station located a few hundred meters downstream from the dam, are probably overestimated since the setting in water of the dam because of the fast precipitation of the dissolved iron in the samples.
    - For the stations located on Konkouré and downstream from the dam of Garafiri (K04-a, K07, K08, K09-a, K09-b and K11), the sampling rate was undoubtedly insufficient compared to the many variations of flows imposed by the hydroelectric power plant of Garafiri.
    - The daily variations of flows (from # 25 m^3/s to # 100 m^3/s) as well as the stops and the brutal resumptions of exploitation at the power plant of Garafiri probably have a

considerable impact on solid transport in the river: rehandling of the base sediments, wrenching of the banks...

- The quantities of suspended solid having transited at the K11 station in 2000, 2001 and 2002 are respectively 91 000 tons, 128 000 tons and 97 000 tons.

- Water quality

  - The analyses carried out highlighted the main physico-chemical characteristics of the water from the Garafiri reservoir.
  - In the reservoir, the main characteristic is the weak mineralization of the river, with the use of conductivity measurements to follow the evolution of the water quality (example of measurements downstream from Fria).
  - In the reservoir, the vertical structure of the water column, with an anoxic deep layer, conditions the biology of the lake and the distribution of the organizations. The low content of nutritive elements limits the development of the micro-algae, but the fish can use the primary production of the algae epiphytes on the tree trunks immersed or benthic in the zones of edge.
  - During these first years of operation, the water taken for the hydroelectric production is generally anoxic. On the other hand, it can cause problems by saturating cooling water filters. It seems indeed that this water is partly reoxygenated at this point.
  - Downstream from the dam, turbulence supports a fast reoxygenation of water, and the quality of water can be regarded as good to approximately 15-20 km of the dam. The water environment is however disturbed to a significant distance because of the fast fluctuation of the flows (alternation day-night) resulting from the cycle of the electricity production in response to the urban demand.

- Hydrodynamics and sedimentary Evolution of the Konkouré estuary

  - The hydrodynamic parameters (current of tide and river) as well as the physical parameters (morphology and nature of the beds) and hydrological (salinity, temperature, suspended solid) were monitored on two time-scales, one semi-monthly underlining the effects of the tide, and the other annually underlining the specific flow of the river (low water level or rising).
  - The series of measurements carried out constitute a significant database.
  - The impacts of the dam are difficult to highlight directly because they are hardly noticeable when they exist.
  - In rain season there is an effect of discharge of estuary sediments into the ocean. The upstream part of the estuary operates strictly as a river.
  - In dry season, the tide reintroduces sediments in the estuary which will migrate upstream.
  - There is a great variability of the estuary system due to the river flows and the weather conditions. The most significant impacts of the dam of Garafiri appear on the upper part of the estuary in low water periods where a significant retreat of salinity is expected.
  - In low water period, the restored flows of the dam generate an intensification of the currents of ebb in the upstream parts and medians of the estuary, as well as a light extension of the duration of the ebb upstream.
  - On the 8 sections of reference and after 3 years of observation, no significant evolution was observed on the transversal profiles. When variations were observed, those are not therefore significant and remained limited.
  - The paroxysmal natural phenomena (swell, wind, raw...) have certainly much more consequences on the morphology of the estuary and the littoral that the hydroelectric installation of Garafiri had since 1998. On the other hand, the effects of the

installation and its exploitation can, in the long term, have irreversible impacts on the environment.

- Follow-up of the socio-economic impacts in the Konkouré estuary
    - The results are based on investigations carried out on populations, in-situ campaigns and standard questionnaires validated by various specialists. The goal of this work was to follow the resources exploited in the estuary, their output, the methods of production but also the use and quality of the arable lands.
    - The impact of the operation of the dam of Garafiri mainly concerns the higher and median parts of the estuary. In these zones, one observes a clear improvement of the production of rice, the abandonment of the extraction of salt little practised before and the modification of the allocation of halieutic resources (fish and oysters).
    - In general, the populations regard these modifications as positive, although they announced the multiplication of constraints related to the exploitation of the resources.
    - In lower estuary where salt production and fishing are more practised, the changes observed only slightly compromise these activities.
- Aquatic life
    - Continental and estuary fish
        - The modification of local conditions and its possible effects on fish occur in the reservoir, in the course of the Konkouré river downstream of the dam, and in the estuary where minimum flows clearly increased.
        - The results are based on experimental fishing carried out on 7 stations of the catchment area and 4 stations in the estuary of the Konkouré river between April 1999 and January 2002.
        - Fifty-two species were identified in the river and 64 in the estuary. Their distribution in the course of time and in the various stations was analyzed by taking account of the biological characteristics of the principal species and by comparing the results with the data published for other continental or estuary environments of West Africa.
        - A biotic index of integrity of the fish settlement (Index of Biotic Integrity, or IBI) was developed for the basin of Konkouré at the time of a former study (Hugueny et al. 1996) and its effectiveness was tested within the framework of the impact study of the bauxite treatment plant. To increase the sensitivity of IBI to the particular disturbances induced by a hydroelectric dam, metric measurements were used to account for the intensity of the reproduction of fish. This new index was used to compare the evolution of the fish settlement in locations subjected to the direct effect of the dam with that observed in locations near affluents out of the hydrological influence of the dam. It was noted that natural variability masks the possible effects of the dam during the first years after the reservoir was filled up. The main impact of the dam remains the construction of a settlement and lake which gives place to an active fishing.
        - In the estuary, the results obtained indicate that some fresh water species, like *Lates niloticus,* are captured a little more downstream in the estuary than before the construction of the dam, which could be in relation to the increase in the minimum flow and a desalting in the upstream of the estuary. However, precipitations on the basin during years 1999 and 2001 were very different, and natural variability is thus superimposed on the more durable modification due to the dam.
        - The data obtained do not make it possible to highlight a short-term modification of the distribution of the species fished in the lake and the basin after the implementation of the dam.
    - Oyster settlements in the Konkouré estuary

- A study of July 1992 (CERESCOR) indicates that oysters were present in the whole of the Konkouré estuary. The distribution of oysters during the period 1999 - 2002 is different; this difference which could be linked to the construction and the exploitation of the dam of Garafiri.
- In addition to the variability of an oyster population over a period of time, there is also a strong variability at a same location. But the transition from a well-developed colony of oysters to the absence of oysters leaves no ambiguity. Renewing campaigns were carried out to specify the persistence in time of the observations carried out.
- Three main zones were identified: upper estuary (upstream of Kakounssou) where the oysters disappeared as of March 2000, the intermediate zone (between Kakounssou and the island of Bokhinéné) where they quickly became rare before disappearing in December 2001, and the zone downstream of the estuary including Bouramaya which does not seem to be affected by the changes.
- Disappearance in March 2000 of oysters of the zone upstream of the estuary can be the consequence of a fall of salinity in this zone during the dry seasons; lower salinity due to the exploitation of the Garafiri plant (increase of minimum flows).

In conclusion, the Garafiri hydroelectric project had impacts on the estuary and the Konkouré catchment area:

- the Garafiri reservoir can be used for artisanal fishing;

- in the continental river section no notable modification of the ecosystem was identified;

- in the estuary, the increase of minimum flow supported the massive re-entry of continental species, while 6 species seem to have disappeared.

4.2.2 Socio-economic aspects observed at the time of the audit

In addition to the socio-economic impacts highlighted by the studies preliminary to the construction of the project, the site visits highlighted the following aspects.

Resettlement

A study of the populations affected by the Garafiri scheme was undertaken. In general, the populations are not satisfied with the measures taken for their resettlement.

For the other sites, no study was carried out at the time, and we could not establish at the time of the audit if populations had to be moved. On the other hand, we noted at the time of the audit that there were no populations in the immediate vicinity of the power stations, on the other hand villages are established not far from the reservoirs.

Deforestation

At the time of our visit of the Grandes Chutes dam, we met a delegation of *Guinée Ecologie*, accompanied by the sub-prefect of Mambia, which was appointed by the embassy of Canada to assess the degradations caused on the environment by the populations (stockbreeders and coal producers). The aim of the assessment if to establish the requirements regarding restoration and afforestation required to better safeguard the reservoir.

Fish

Fishing is not regulated on the rivers. Thus, EDG noted that the populations fished young as well as adult fish, which accentuates the imbalance of this ecosystem.

Agriculture

Before the construction of the hydroelectric power stations and associated reservoirs, the now drowned land was used for agricultural and breeding activities.

Many abandoned plantations were present around Grandes Chutes, Banéah and Donkéa. The electrification of these zones allowed the populations to stay and agriculture and fishing to develop.

Health

Within the framework of the Garafiri project, health centers were built.

Education

Within the framework of the Garafiri project, schools were built. However, one is damaged and thus not currently used.

High voltage lines

The main socio-economic impact associated with the operation of the power station concerns the risk of accident and the safety and health risks for the public (moreover, because of the presence of hydrocarbons on the site, the fire hazards are significant).

The electricity transmission pylons and lines also present a risk for the public: electrocution or injury caused by the fall of power lines / pylons, or by poor signalling of the pylons.

Passage point

In Banéah and Garafiri, the installation of a dam made it possible to create a point of passage from one side of the bank to the other.

Electrification

As much as possible, EDG carried out the electrification of the villages in the vicinity of the hydroelectric power stations. Sometimes, these installations (in particular at Garafiri) were carried out by EDG with makeshift solutions.

Industries nearby

Diamond mines located downstream from Banéah and Donkéa are locally responsible for environmental pollution.

Land property

In the absence of established property limits, the farmers come to work the ground on the "doorstep" of the power stations.

In conclusion, except for the Garafiri scheme, socio-economic impacts of the audited hydroelectric power stations are not known or are not quantified.
The major socio-economic impacts concern the resettlement of populations and the destruction of an ecosystem.
Moreover, it would be useful to carry out a study of the environmental impacts of the audited hydroelectric power stations, or a follow-up of the impacts with regard to the Garafiri scheme.

4.2.3 Water management

4.2.3.1 Water for domestic use

In general, the waters from the reservoirs are used for human consumption by nearby populations and the employees of the power stations. The villages which were moved during the construction of the Garafiri scheme were equipped with manual pumps.

Cases of diarrhoea were reported.

In addition, the *Compagnie de Bauxite de Kindia* (CBK) as well as the *Société des Eaux de Guinée* (SEG) pump water from the Grandes Chutes reservoir. Because of SEG requirements, the power station of Grandes Chutes must sometimes stop functioning.

4.2.3.2 Water for industrial use

The water of the reservoir is used for:

- Production of electricity through passage in the turbines
- The cooling of the equipment:

  The cooling waters come from reservoirs. Automatic filters were placed before the alternators
- Production of cooling water (non-operational):

  Garafiri/Donkéa

  The room for the production of cooling water is not functional due to a heating problem when the oil's pressure is increased, and presence of red muds.

  Sediments of red color come to clog the cooling agents. Thus, heat exchange is damaged, and the machines overheat. The current systems of filtration do not make it possible to solve this problem. Solutions are being studied.
- Floor cleaning:

  In general, floors are washed with water and the soap. This water is evacuated with turbinated water.
- Human waste:

  On each site, human waste (excreta and wastewater) is collected into a concrete pit which has never been emptied to date.

4.2.3.3 Leakage

Water leakages were identified on various equipments. At Garafiri, this water passes through an oil separator before discharge in the restitution. However we could not establish with certainty if all potential oil polluted waters passed through the separator.

4.2.3.4 Surface waters

In order to avoid the erosion of the dams, surface waters must be drained.

Specific gutters/drains were installed to collect surface waters from the surface of the Garafiri dam as well as underground waters from the mountain.

4.2.3.5 Downstream restitution

The valves of the dams are not systematically watertight. Under these conditions, a minimum flow is restored downstream. The associated quantity of water is unknown.

The power stations do not have obligation to provide a minimum flow downstream, or to respect a maximum flow. Moreover, significant flows can be generated when the gates are opened when the reservoir is too full, or when the turbines start.

Water thus restored is used for fishing and human consumption.

4.2.3.6 Water quality

The quality of the water used and discharged is not evaluated. However, based on our site observations, it is probable that this water is polluted with hydrocarbons.

In addition, the persons in charge of the power stations of Donkéa and Grandes Chutes confirmed that the pipes of the power stations were damaged due to a poor quality of water due to the activities of the diamond cutters upstream of the sites.

The water flowing from the Kalé reservoir to the Donkéa power plant through a canal is polluted by the effluents of the hen breeders installed along the canal.

At Garafiri, turbinated water comes from the bottom of reservoir. It contains iron hydroxide.

The issues associated with water management will only be solved once:
- the quality of pumped/discharged water is assessed
- quantification of the impacts installation
- implementation of solutions recommended in the former studies of 2003 and 2004 (mainly repair/replacement of parts/equipments)
- awareness of the personnel on better environmental management is improved
- repair of leaking equipments and installation of oil separators

4.2.4 Management of air emissions

In addition to the emissions generated by the vehicles of the employees and the emergency power units which function a few minutes a day, the hydroelectric power stations are not at the origin of major atmospheric emissions.

No specific issue was identified.

4.2.5 Management of hazardous products

4.2.5.1 Hazardous substances

Hazardous substances used on site are present in small quantities; they comprise:

- Lubricating oils (for engines, parts) or of transformer oils (approximately ten barrels of 200L are stored on each site);

  A generator consumes approximately 1000L of oil per month;
- Diesel for the emergency power unit (above ground storage of 5000L at Grandes Chutes, Banéah, and Donkéa; underground storage tank of 5000L at Garafiri);
- Standard solvents for cleaning the equipments (20L containers).

Note: In addition, EDG regularly lubricates the draining pipe located at the base of the Kalé reservoir by pouring oil from the top of the drain. This practice is to be proscribed.

In Garafiri and Donkéa, EDG also uses acids for batteries, and hypochlorite (soda, chlorine, acid) for the treatment of the water pumped which is then used for human consumption at the power station and the Garafiri city.

4.2.5.2 Transformers

The site is equipped with several oil transformers. With the exception of the transformers of the power station of Garafiri, the transformers are not systematically equipped with retention. Leaks were identified at Donkéa.

EDG does not know if these oils contain of PCBs. A characterization campaign is in hand.

4.2.5.3 SF6

The circuit breakers of the groups contain SF6 (sulphur hexafluoride). The SF6 is a greenhouse gas (its PRG compared to CO_2 is 23900). The equipment must be managed in an adequate manner in order to avoid the emission of SF6 into the atmosphere. In the event of a leak, the equipment is replaced.

4.2.5.4 Asbestos

The site personnel are not aware of the presence of asbestos on the sites. However, after visual inspection of the roof of the buildings located in the Garafiri city, it seemed that they contained asbestos (cement-sheeting).

Many hazardous products in small quantities are present at the hydroelectric power stations; however, their management is inadequate or non-existent. Thus, the problems related to the management of the hazardous products will only be solved through:

- installation of adequate retentions

- increase of personnel's awareness regarding better environmental management

- repair of leaking equipment and installation of oil separators

Moreover, a specific instruction regarding the management of hazardous products and an inventory of these products should be prepared and updated regularly for each site.

4.2.6 Waste management

Waste generated on the sites comprise mainly:

- Ordinary waste (paper, refuse)
- Soiled fabric
- Empty cans/barrels (formerly containing hazardous substances)
- Organic matter recovered on the grids
- Used oils

Waste management is not organised. Thus, on some sites, waste is either burnt, or thrown away (in the surrounding environment). The empty cans/barrels are generally re-used after being washed (dirty water is evacuated in the restitution). Used oils are recovered by third parties.

There is no monitoring of this waste either in a qualitative or quantitative manner.

The issues associated with the management of waste are closely related to the issues associated with the management of water and air. Thus, these issues will only be solved once the solutions recommended previously, in particular by improving personnel's awareness on environmental problems are implemented. Moreover, a specific procedure regarding waste management should be prepared.

4.2.7 Pollution observed

Many oil leaks occur on the equipments because of insufficient maintenance (i.e. defective parts are not replaced due to financial problems).

When visiting the sites, traces of pollution were identified in the maintenance workshops (floors soiled with hydrocarbons, mainly in Donkéa and Garafiri), and at the location of some transformers (Grandes Chutes, Donkéa mainly).

As long as the solutions recommended previously (mainly repair/replacement of parts/equipments) and adequate training / awareness are not implemented, the risks of pollution of the environment will continue to exist.

4.2.8 Noise levels

When they are under operation, the groups generate significant levels of noise inside the power stations. However, the alternators/turbines are located in the station's basements; as such, the noise is attenuated and less noticed from outside.

In addition, no dwellings are located near the power stations.

No monitoring of noise levels was carried out to date.

We recommend that noise emission levels be monitored inside the power plants. Personal protective equipments ((ear-protection) will have to be provided to the personnel exposed to elevated noise levels.

4.2.9 Health & safety

4.2.9.1 Inventory of accidents

There is no register of accidents on the sites, and no specific reporting framework. However, reports were prepared for recent incidents.

Nevertheless, the personnel of the power stations confirmed that some major fires occurred within the power stations. At Grandes Chutes, an alternator took fire in 1985. In Donkéa, in 2004, an outdoor transformer took fire after being struck by lightning. Oil was spread on the ground. The fire was extinguished with water. A circuit breaker burst on January 16, 2005 on the Donkéa site; this fire was extinguished with water.

Two people drowned in the feeder canal from the Kalé reservoir to the power station of Donkéa. There is no safety fence to prevent people from approaching some.

An electric relay took fire in 2005 in Banéah.

4.2.9.2 Access

The access to the power stations is guarded 24h/24h. The site is equipped with a padlocked fence.

4.2.9.3 Maintenance

4.2.9.3.1 Reservoirs

Reservoirs are equipped with probes making it possible to transmit the level of the water in the reservoirs to the associated control room. However, these probes usually malfunction, which means that the personnel of the power stations carries out a visual reading of the water level in the reservoir each morning.

A team inspects the reservoirs everyday to check the state of the equipment of the dam (grid and evaluation of potential repair works required).

The grids are manually cleaned at regular intervals. Waste recovered is deposited near the reservoir.

The underground galleries are controlled every 5 years.

The feeder canal to Donkéa is drained once a year to remove sediments and waste.

There is no monitoring of the silting of reservoirs. However, it was noted that the outputs are weaker in dry season due to this fact.

Additionally, inspections of the dams are carried out by the hydroelectric technical department of EDG by means of annual auscultations and topographic surveys. No major problem was raised to date, although cracks are observed at the dams.

For the Garafiri dam, the personnel of the power stations also measure the movements of the dam. Piezometers were also placed all along the dam to check if water infiltrates under the dam. Piezometric levels are checked monthly.

It should be noted that the auxiliaries of Grandes Chutes can feed the power station of Donkéa in the event of a prolonged power cut (due to maintenance) and vice versa.

4.2.9.3.2 Power stations

A monthly maintenance planning is carried out; it includes daily tasks. Major repairs are carried out by a team of Conakry or an external company. Thus, regular inspections (daily, weekly, quarterly, semi-annually or annually depending on the situation) are carried out in the power stations by the personnel of the power stations.

Because of the frequency of the bush fires occurring near the sites (due to stockbreeders), EDG carries out a trimming of the immediate surroundings of the site twice a year.

A daily inspection of the machines is carried out.

In Garafiri, a complete inspection of the equipment takes place twice a year.

4.2.9.4 Personal protective equipments

The type and quantity of personal protective equipments present on site vary from one site to another. However, it was noted that on each site, available personal protective equipments are insufficient. There are sometimes ear protective devices, gloves, helmets etc. Stocks are not renewed due to the lack of funds.

4.2.9.5 Emergency response

In general, in case of an accident, the site is evacuated, or the injured person is evacuated to the nearest health center. However, no particular protocol exists in the event of an accident.

For Garafiri, instructions of evacuation were elaborated.

There is no specific protocol regarding the information of the populations located downstream of the reservoirs.

Employees must be trained as rescuers/first-aid workers and follow a regular recycling.
Appropriate personal protective equipments must be provided to the employees according to the tasks they carry out.
A specific instruction regarding the information and the evacuation of the populations which would be affected in the event of a structural failure of the dams must be prepared.

4.2.10 Complaints

4.2.10.1 Complaints from the populations

4.2.10.1.1 Hydroelectric power stations (except Garafiri)

To date, with the exception of the villagers close to the dam of Garafiri, the populations did not complain to EDG regarding harmful effects EDG's activities could generate.

4.2.10.1.2 Hydroelectric power station of Garafiri

The construction of the dam of Garafiri and associated water reservoir required the resettlement of 25 villages (approximately 2000 people).

The following complaints were made by the resettled populations:

- The quality of the dwellings in which they were resettled: innovating solutions had been adopted at the time (tiles for the roofs); however, when the roofs are damaged, the inhabitants cannot repair them. Moreover, the school and the health center are damaged.
- The mosques were not always rebuilt.
- The availability of water for human consumption; as an example, for one of the villages resettled which currently comprises 600 people, there are two wells; however the chief of the village explained that the delivered flow was insufficient. Moreover, a feeding trough was scheduled for the animals, but not constructed.

They also complain about the long distance to their cultivable land. EDG's employees drive the people to their villages.

4.2.10.2 Complaints from EDG

Grandes Chutes

EDG complains that the populations cross the river on top of the dam as there is a risk of drowning. EDG thus installed a grid to prevent the populations from passing. It was noted at the time of the visit of the site that this grid was not sufficient to prevent the populations from passing.

EDG confirmed that the populations installed near the power stations and associated installations are responsible for the deforestation and bush fires. EDG does not envisage, at the present time, to reforest the affected areas, in particular on the banks of the reservoirs to limit erosions and thus the increased accumulation of sediments at the bottom of the reservoir.

For Grandes Chutes, EDG explained why the geology was not suitable for planting.

Donkéa/Banéah

On several occasions, EDG requested from the administration that the property limits are marked, in order to prevent the shepherds/populations to come near the reservoirs (Kalé, Banéah). Indeed, the banks of those reservoirs become eroded due to the agricultural activities carried out there. In addition, the stockbreeders put their herds on the dams; this creates erosion which could damage the structural integrity of the dams.

Garafiri

EDG is trying to prevent fishermen from coming too close near the water intake. EDG noted a constant deforestation because of the presence of coalmen in the area. Large and small trees are regularly cut down. A plan of afforestation would thus not be effective if these practices continued.

In addition, EDG noted that resettled populations do not maintain the fruit trees which were replanted.

4.2.11 Fire protection

The sites are equipped with fire extinguishers in insufficient numbers. They are not checked regularly.

The alternators are all equipped with fire detection systems associated with automatic CO_2 extinction. However, the persons in charge of the sites confirmed that these systems were generally not operational. Similarly, the detectors located on the alternators are not all operational.

Some employees followed a specific training regarding emergency response in the event of fire. However, no update was carried out since. The information transmitted orally by EDG seems to indicate that the personnel of EDG is not sufficiently trained to be able to answer effectively in the event of a fire. Indeed, the personnel tried to extinguish fires which had occurred on electric components with water, which is not suitable.

All the personnel should be trained to handle fire extinguishers.

Fire extinguishers must be provided in sufficient numbers, and be checked annually. The personnel should follow a training regarding the use of fire extinguishers and have regular recycling.
Exercises regarding fire extinguishers handling and site evacuation should be carried out at regular intervals.

4.3 Energy management

4.3.1 Production

The energy produced by the thermal power station and the hydroelectric power stations is gathered at Tombo, then redistributed. Currently, 40% of the energy produced comes from the Tombo power station and 60% from the hydroelectric power stations.

A daily energy production programme is established by the direction of EDG in Conakry. The hydroelectric power stations function according to this program which is based on the water levels available in the reservoirs which are regularly transmitted from the power stations to the head office of EDG in Conakry.

As an example, the production on December 12th, 2005 was as follows (the state of the groups on this date appears in appendix 10):

- Tombo I: No operation (re-starting date unknown)
- Tombo II: No operation (re-starting date unknown)
- Tombo III: No operation
  (re-starting date: February and March 2006 for two of the four groups)
- Tombo V: 2 groups functioned during 13 hours each
- Garafiri: the 3 groups functioned during 7h and 13 hours
- Grandes Chutes: the four groups functioned during 13h and 24 hours
- Donkéa: the two groups functioned during 24hours
- Banéah: A group does not function (re-starting unknown)
  The second group functioned during 24h

The daily ouput was 111MW.

The rate of distribution was 65%. Some districts in Conakry receive electricity 24h/24h while others receive electricity only from night.

For information, we integrated in appendix 11, the daily power graph for December 25th, 2005.

4.3.2 Maintenance

4.3.3 Electricity production installations

The power stations are equipped with control rooms where the various monitoring parameters are displayed. Moreover, the power stations have a 24h/24h presence.

The controls carried out at the power stations are detailed in the previous paragraphs.

In general, EDG confirmed that because of financial problems, the used parts of the equipments were not replaced.

Reports/ratios of maintenance are prepared and the requests for investments (in order to repair the equipments) are sent to EDG's head office. However, for financial reasons, these investments were generally not granted.

4.3.3.1 Distribution network

The equipment department of EDG confirmed that there were weaknesses in the maintenance programme for the power lines, because of the lack of material, due to financial problems.

In 1996/1997, 100% of the high voltage network and 100% of the low voltage network was rehabilitated in Conakry.

However, protections on low and medium voltage were deteriorated in most distribution stations; the fuses were not replaced.

As such, in 2004/2005, 80 transformers were damaged; these do not function any more.

Moreover, EDG does not have to date any cable or transformer in stock. However, many transformers are in overload because of the strong growth in energy demand.

4.3.3.2 Transmission network

The grounding cables for the pylons are regularly torn off by the populations which want to recover copper. When EDG identifies such an issue, the cables are repaired / replaced.

However, EDG does not have any cable in stock at the moment.

The equipments of the power stations are checked regularly. However, because of insufficient funds, parts/equipments are not changed or repaired.

4.4 Organization

4.4.1 Environmental department

EDG's environmental policy is shown in appendix 3. It indicates that in order to carry out its missions, it uses all the practical means to protect and promote the environment, and that the protection and the development of the environment is one of the main concerns of EDG's employees and partners.

The environmental department of EDG was created in 2002. Its role is described in the directives which is shown in appendix 12, and synthesized below.

The tasks of the environmental department are as follows:

- to evaluate and manage the pollutants generated by the thermal power plant.
- To prepare a monitoring checklist applicable to all the dams of EDG's hydroelectric installations. This checklist will make it possible to monitor the variations of natural and anthropogenic phenomena.
- to carry out the inventory of all the equipment likely to contain persistent organic pollutants in order to downgrade them gradually electrical supply network of EDG.
- to supervise the high voltage lines in order to protect them.
- to manage the surfaces occupied by the transformers in order to avoid their use, as well as the programmes for pruning under the low and medium voltage lines.
- to establish a guide for the environmental impact studies specific to EDG.

A short-term action plan was established in 2002 by the environmental department. It is presented in appendix 13. It included 5 points:

- Inventory of the environmental problems generated by the power station of TOMBO
- Inventory of the environmental problems along the lines high voltage, of the stations and the transformers
- Inventory of the environmental problems in the catchment area of the hydroelectric installations
- Preparation of environmental assessments for TOMBO and the hydroelectric power plant
- Afforestation at Garafiri

To date, the principles of the Directive were not implemented. The action plan was not put into practice (except for the characterization of the effluents of the power station of TOMBO), due to financial problems. A study was launched to identify EDG's equipments containing PCBs.

4.4.2 Training department

EDG has a training department located in Conakry and a training center in Garafiri (which is not operational at the moment). This service comprises 10 employees.

The training scheme is managed from Conakry.

The training department brings support to the operational directions. It identifies the training requirements for the operators, and other departments inside the company. It is also in charge of the design of the internal programs and the transmission to a targeted public.

When EDG does not have the in-house resources to provide trainings, the training department can call upon external companies.

All new employees follow training on safety at work (including electricity risks).

The personnel have a quarterly or semi-annual evaluation. Training needs are identified at this stage. The actions which must be carried out consequently are targeted to achieve the national objectives.

Finally, a training scheme is actually being prepared. It integrates all the needs and objectives identified; this program is very general. It is not an annual plan, but a plan including all potential training needs. Thus, it will up to EDG's direction to establish the priorities.

The fields identified in the training scheme are as follows:

- Commercial
- Secretarial
- Office automation
- Data processing
- Languages
- Accounts department/ management
- Human resources management
- Quality
- Technique of production and transport
- Technique of distribution
- Communication skills
- Electricity

We recommend the implementation of the training programme, with the coordination of the environmental service for the aspects requiring a particular awareness (waste, hazardous products).

4.4.3 Safety & prevention department

The safety & prevention department includes three sections:

- Prevention: this section is in charge of periodical inspections of the installations and equipments; EDG is looking for two inspectors to recruit as these jobs are actually vacant
- Occupational safety: this section deals with the standards and accident statistics; it carries out the preliminary investigations in the event of accident; it is also in charge of the control of fire protection systems (extinguishers etc.)
- Occupational health: This section was created 2 to 3 years ago; it deals with the "maintenance" of the work environment; currently, EDG is looking for health & environmental representatives, as these jobs are actually vacant.

A work plan which includes regular visits of the HTBT / MTBT networks, as well as the thermal and hydroelectric installations is established for each section.

Reports of inspection are prepared and required investments are identified in the reports, so that EDG's direction can authorize / grant them or not. However, for financial reasons, most investments were rejected to date.

At present, the communication between EDG's head office in Conakry and the power stations are carried out by phone. A system of radio transmission (24h/24h) is under study.

The section established a management procedure regarding safety of equipments. This procedure was transmitted to all employees. However it should be updated.

There is a safety & prevention handbook, but no health & safety handbook. However, charts regarding chemicals used exist.

In January 2006, EDG confirmed that they planned to increase employees' awareness on chemical risks and to develop a specific handbook on these risks.
The safety & prevention department is also aware of the need to prepare site maps.

The safety & prevention department highlights particular needs during the inspections which it carries out. It is essential that the needs identified are treated.

5 Environmental and social management framework

5.1 General presentation of Guinea

5.1.1 Geography

The Republic of Guinea is located in the southwestern part of Occidental Africa between 7° 05 and 12° 51 of Northern latitude and 7° 30 and 15° 10 of Western longitude, halfway between the equator and the tropic of Cancer.

It covers a surface of 245 857 km^2. It is a coastal country with 300 km of littoral (Atlantic-west), and a relief comprising both plains in the littoral at low altitude and mountainous zones inside the country, reaching in certain places an altitude of more than 1500m.

The great diversity of the landscapes resulting from the large variety of the contours contributes to the creation of many local climates with their own ecosystems making of Guinea a country with four distinct natural areas: Low Guinea or Maritime Guinea, Middle Guinea, High Guinea and Forestry Guinea.

Guinea has a very contrasted relief which is characterized in Low Guinea by embedded estuaries and littoral plains dominated by cliffs and the mountainous chain of Kakoulima with its peak at 1007 m height located 50 km North-East of Conakry. In Middle Guinea, there is the mountainous chain of Fouta Djallon with an average altitude of 1000 m with peaks at 1515 m in Mali, comprising valleys and ravines precipice. In the north of Fouta, we can find low plains which are, with the vast plains of High Guinea, an extension of the plains of Soudan. The plains of High Guinea, generally alluvial, are drained by the Niger river and its affluents. Forestry Guinea is a zone covered with forests of very complex topography. The Guinean Dorsal is a chain of mountains chain with a pick at 1752m height: mount Nimba.

5.1.2 Flora

Regarding vegetation, the country comprised four great geo-ecological fields: mangrove, dry forest, savanna and wet dense forest.

Guinea has varied ecosystems: mangroves, forests (wet, ombrophilous, mesophilic and elevated), dry forests and savannas which are habitats for a diversified fauna and a flora.

The mangrove is the amphibian forest which represents a transition between the sea and the continent and which extends in Low Guinea on the entire Atlantic coast on more than 300 km length.

In addition to the mangrove, Low Guinea is covered in places by **the clear coastal forest**, a zone of international importance for the migratory birds of Africa-Eurasia.

The practice of an extensive agriculture, the irrational exploitation of wood and the agricultural plantations hazardously compromise the sustainability of this forest.

The savanna which is the result of the degradation of the wood formations, covers most of the territory. We can distinguish between:

Guinean savannas develop in hot and rather wet climates with rare raining events, and a long dry season during which grass becomes yellow and dies. At each dry season, bush fires occur in the Guinean savannas.

The dense Guinean forest is characterized by a closed formation where the vegetation is exuberant, very high trees are present and where a constant moisture and a half light reigns. The most significant factors which govern the development of this dense forest are the temperature and the moisture. The wet seasons are longer (8 to 9 months), the annual thermal amplitude is smaller.

5.1.3 Fauna

The dry and dense Guinean forest, which covers the northern half of Guinea except for Fouta Djallon, undoubtedly contains the richest mammal fauna of the country, with animals like lions, panthers, antelopes, hinds, agoutis, hares and others.

5.1.4 Endangered ecosystems

Erosion caused the sedimentation and an accelerated silting of the rivers, involving the modification of the physico-chemical characteristics of the waters, then a change in biological balances.

5.1.5 Agriculture

Agriculture is the main productive occupation in Guinea since it concerns more than 85% of the population.

The agricultural activities are generally undertaken on individual small-scale farms whose average size is approximately 2,5 ha per family of 6 to 8 people. This average varies from one area to another. It is smaller in Fouta Djallon where the major part of the exploitations would vary between 0,5 and 1 ha, while in the other areas this average is between 1 and 5 ha.

Bush fires and various clearings are estimated at approximately 115 000 ha per annum including 15 000 ha of dense forest (FAO, 1991), the overgrazing, the uncontrolled exploitation of wood, involve a process of degradation of these resources.

5.1.6 Surface waters

Marine resources are high in Guinean waters: plankton to mammals, as well as aquatic plants, invertebrates, fish and reptiles.

But at the moment, the Guinean coastal zone suffers from a progressive degradation which has an impact on the marine ecosystem. This degradation is caused by coastal erosion and the effluents discharged into the sea which contain petroleum products, solid and liquid waste causing significant pollution. The sources of these effluents are industrial and domestic. This waste undergoes a transformation in seawater while creating harmful substances and elements for the marine ecosystem. The degradation of the mangrove is an example of these harmful effects.

5.1.7 Livelihood

The Guinean population was estimated in 1997 at approximately 7 million inhabitants with a demographic growth rate of 2,5% on average. The majority of the population lives in a rural environment, dealing primarily with agricultural activities.

The rural Guinean environment has a rather precarious balance in comparison with the negative impacts of the human activities on the natural resources and the "receiving" environments: natural covers are degraded; soils dry up and are eroded; biological species disappear from rivers.

5.1.8 Industries

The density of Guinean industrial activities is for the moment quite low. It mainly comprises some large mining companies and small manufacturing companies. The cumulated effects of these industries on the natural resources and the environment are however not negligible.

Guinea has significant bauxite layers of ore (20 billion tons), iron (1 billion tons), nickel (73 million tons), graphite (11.300 tons), titanium (100.000 tons), gold (10.000 tons) and diamond (25 million carats); these geological layers are or will be exploited. All the deposits are worked using open sky techniques.

The effects of the mining activities on the natural resources and the environment are numerous; it mainly concerns the loss of natural cover and impoverishment of the soils, the pollution and the silting of the rivers, air pollution.

The actual industrial environment includes some rare industries (in particular agricultural processing industries) and substitution processing industries manufacturing soaps, sheets, plastics...).

The building material sector is dominated by *Ciments de Guinée* and associated concrete-reinforcing steel and metal pipe factories.

Industries generally have a significant impact on the environment with the waste which they generate and a significant effect on the natural resources that they exploit. However, Guinea is not yet a truly industrial country as there are only a few activities in this field except for mining.

5.1.9 Energy situation

The Government continued its efforts aiming at increasing the national capacity of energy production, through the hydroelectric scheme of Garafiri (75 megawatts of power available since 1999), to respond to the increased electricity needs in Conakry.

For the past years, a clear degradation of the electricity power supply in Conakry is noted due to a lack of financial resources to renew the parts and maintain the installations.

5.1.10 Major environmental issues in Guinea

Major environmental issues listed in Guinea relate to the drastic reduction of the natural cover of the country with uncontrolled deforestation due to clearings and bush fires, which are responsible for ground erosion, loss of ground fertility, and loss of biological diversity. The surface of Guinean tropical forest lost each year is estimated at 86.000 ha, for a total of approximately 6.692.000 ha (in 1990); only 0.7% of the territory is classified as protected areas. Out of 190 species of mammals found in Guinea, 17 are endangered whereas 6 species of birds are nearly extinct compared to a total of 529 species and among 3000 types of plants including 88 endemic, and 36 are considered to be threatened.

The reduction in the natural cover and biological diversity involved the degradation of the land which is the major environmental problem of Guinean rural environments. This issue will persist as long as the country does not implement necessary macro-economic balances, land control, pricing policies on natural resources, with a participative management for the forests.

Although the water resources of the country are potentially very significant, the absence of monitoring and the inadequate management constitute a true problem which has impacts on the environment.

5.2 Political, administrative and legislative framework

5.2.1 Environmental and social policy

The policies and current strategies of development in Guinea are related to reforms engaged since 1985, which aim at the macro-economic and financial cleansing, the promotion of the private sector, the creation of the basic infrastructures necessary to an accelerated economic growth coupled with a significant support with the social development. Following an elaboration process which was often based on participative steps and the consultation of the populations at the base, the applicable policies and national strategies are currently as follows:

- **The policy of decentralization and devolution:** started in December 1985 (Ordinance N° 069) with an emphasis on territorial devolution and decentralization; as such, 38 urban communes and 33 rural communities of development (RCD)gathering 2300 rural districts were created. It was reinforced by the mobilization and the organization of the civil company, structured in addition to 690 national NGO, 78 foreign NGO and approximately 3 800 co-operatives and groups. Moreover, by the integration of the planning processes at the RCD and the prefectures, decentralization became an essential component of the development policy and establishment of the participative territorial governance.

- **Strategy of Poverty Reduction of (SPR)**: in accordance with the synthesis of a series of strategy documents (National Program for Human Development, Strategy for Assistance in Guinea and "Guinea, Vision 2010" in particular) the government initiated and controlled the development of the SPR, by making participation of all the social components of the nation. The Document of Strategy is considered today as the main framework for governmental interventions as well as for partners acting to develop Guinea.

- **The Letter on Agricultural Policy for Development 2 (LAPD 2)** constitutes the main document on agricultural and rural policy for Guinea over the period 1997 - 2005. One of the major objectives of the LAPD 2 relates to the rational use and the sustainable management of natural resources (ground, National Forestry Commission as well as the biodiversity).

- **The Declaration of Land Policy in Rural Environment (DLPRE)** is of major importance for rural development.

- **The National Environmental Action Plan (NEAP)** constitutes the base of the Guinean environmental policy. The National Environmental Action Plan constitutes an adequate framework to facilitate the implementation of a participative policy for sustainable management of the natural resources and environment. The NEAP showed that Guinea has a very high water potential, varied ecosystems, varied fauna and flora, and a great maritime zone, while underlining the presence of significant anthropogenic pressures due to an unsuited exploitation of the resources. Four of the five topics considered for the rural program of the NEAP are: (i) the management of soils, (ii) the management of natural covers, (iii) the management of wild fauna and (iv) the management of surface water.

- **The National Forestry Action Plan (NFAP)** was adopted in 1987 and was the subject of a review in 1992. The main objectives of the PAFN were to work out a general strategy of development in the forest sector. The forest policy is based on six principles: (i) to ensure the sustainability of the national forest, (ii) to arrange and guarantee surfaces which must be permanently devoted to the forests, (iii) to apply the best methods to provide the maximum of goods and advantages for an unlimited period, (iv) to help and control the various aspects of the exploitation, the transformation and the commercial activities associated with the products resulting from the forest, (v) to closely associate the

administrations of the companies, associations, communities and all the citizens with the forest policy and (vi) to ensure that the instruments of this policy work.

- **The Master Development Plan for the Mangrove (PDPM)** was set up in 1989, with the support of the European Union. It highlights the main trends for the Guinean mangrove. It represents a coastal ecosystem of first importance, on a surface of approximately 250 000 ha, affected by an annual regression of 4,2%. Its exploitation concerns nearly 2 million inhabitants including fishermen, hunters, rice, fish and wood producers as well as consumers.

5.2.2 Existing Environmental Legislation

Guinean environmental regulations improved significantly by the adoption of several legislative and lawful texts. Among these legislative texts, the following concern environmental assessment:

- Ordinance N° 045/PRG/87 of May 28th, 1987, creating the environmental Code which constitutes the outline management law for the environment;
- Regarding the impact studies, the Department of the Environment will be based initially on the Decree No 199/PRG/SGG/89 codifying the impact studies on the environment (EIA) which specifies the circumstances and conditions in virtue of which it is obligatory to prepare an EIA. When it is established that such a study is required, it must be completed according to the requirements of Decree No 990/MRNE/SGG/90, which states the contents, the methodology and the procedures for an environmental impact assessment.

Specific regulations started to be issued in 1986. It quickly led to the promulgation of several laws.

Thus the mining Code was adopted in 1986 and the environment Code in 1987.

In 1989, pursuant to the environmental Code, three significant decrees were taken to:

- Prevent and control marine pollution,
- Control classified installations, which are at the origin of most prejudicial pollution; and
- Regulate the environmental impact studies.

A modifying ordinance of the environmental Code was also adopted in 1989:

- to prohibit the importation of waste of any kind; and
- The decree on impact studies was supplemented by a decree of 1990 specifying the contents, the methodology and the procedure for ecological evaluation.

In 1989, the forest Code and its associated decree came into force to prepare the legal basis for the conservation and the development of Guinean forests. A few months later, in 1990, the Code for the protection of wild fauna and a legislation on hunting was promulgated. With this text, legal instruments are in place to safeguard ecosystems and sensitive zones, as well as endangered animals and vegetal species and, more generally, a more rational management of wild fauna. The ordinance of 1989 implements a health policy for animals, and its associated decree, adopted a few weeks before this Code, had already instituted measures to protect the national livestock against contagious diseases.

Additionally, we can mention the following texts: the national land code (Ordinance O/92/019/PRG/SGG/92 of 30th March 1992) and water Code (Law L/94/005/CTRN of February 14th, 1994), which are two management standards for ground and water resources.

It is thus observed that with at the moment, the environment in general, the forests, the species, the ecosystems, the marine environment, the mineral substances, the classified installations, the ecological impact studies, pollution, soils, water, land, are already the subject of specific texts.

Gaps remain however in Guinean environmental laws. They are located at two normative levels: basic legislations not yet adopted, and additional texts which need to be adopted to implement existing laws.

The legal and lawful framework for the Guinean environmental protection comprises texts which enact rules of general interest, and texts whose rules govern a specific environmental field.

A common element in Guinean legislative texts on environmental protection concerns the implication of the populations with the management of their own environment. Various forms of popular participation are encouraged: ecological associations, local communities, groups etc. Thus the environmental Code expects that "associations working in the field of the environment" can be recognized by the administration of public utility and have specific advantages associated with this statute ". It invites moreover the ministerial authority in charge of the environment to facilitate "the creation and the operation of environmental protection and environmental development associations, at national and local level. They can be involved in actions designed to train and inform the citizens ".

Environmental legislations also required increased awareness on environmental matters by means of training or information. Under the environmental Code, public and private training / teaching organisations as well as research or information organisations are responsible for training the citizens to environmental problems, by integrating specific programs in their activities in order to improve their knowledge of Guinean environment; and by supporting the broadcast of education and training programmes on environmental problems.

In accordance with the water Code, the use of water for non-domestic end use requires a licence or a concession. In addition, the water Code specifies that measures (specified in the code) must be taken to prevent the harmful effects on water. These measures were not implemented by EDG.

5.2.3 Ministry for Town planning and the Habitat

5.2.3.1 Land title

The land titles are delivered by the Ministry for Town Planning and the Habitat. The national conservative attests property of the ground with publication in the Official Journal.

To obtain a land title, a file must be submitted to the Ministry for Town Planning with the assistance of an expert surveyor.

5.2.3.2 Construction permit

Any administrative request for a new construction must be submitted to the Ministry for Town Planning.

5.2.4 Administrative status of EDG's sites

5.2.4.1 Land property

The sites of EDG do not have any land title attesting that EDG is the owner of the land which they exploit. Property boundaries are unknown and the sites are not regulated by any administrative authorization as required under the environmental Code and the water Code.

That generates difficulties in term of safety of the elements of the production equipments (factory, reservoir). This aspect is detailed in the environmental analyses.

Regularization was undertaken for the power station of Tombo. There has been no reply to date.

We would recommend to regularize the situation relating to land title documents so that EDG can implement the preventive measures which are essential in term of safety of the equipments, on lands which are allotted to them by law.

5.2.4.2 Operating permit

In accordance with the regulation, the hydroelectric power stations should be authorized under the water Code; while the power station should be authorized under the environmental Code due to the respective impacts which they generate on the environment.

To date, EDG does not have any administrative authorisation.

We would recommend regularizing the situation relating to the operating permit so that EDG is provided with specific regulations in terms of environmental management.
However, this administrative authorisations may only be delivered after an environmental impact assessment has been carried out, as specified in the environmental Code.

5.2.5 Environmental and social safeguard policies from the World Bank

In addition to the codes and national environmental legislations, the environmental and social safeguard policies of the World Bank must be taken into account.

POLICY	***APPLICABILITY***
Environmental assessment (OP 4.01)	*Yes*
Natural Habitats (OP 4.04)	*Yes*
Safety of dams (OP 4.37)	*Yes*
Forests (OP 4.36)	*No*
Pest management (OP 4.09)	*Yes*
Indigenous Peoples (OP 4.10)	*No*
Cultural property (OP 4.11)	*No*
Involuntary resettlement (OP 4.12)	*No*
Projects on international waterways (OP 7.50)	*No*

Operational policy referenced PO 4.01 (environmental assessment) is applicable to the sites' activities. Policies associated with natural habitats (PO 4.04), safety of dams (PO 4.37) and Pest Management (PO 4.09) are also applicable as precautionary measures aimed at reducing impacts to minimum levels. Safeguard policies from the World Bank require the consultation of and the disclosure to the public. Standards referred to in this report are those into force when writing this report. A new version of the World Bank's policies will be issued later this year (2006).

- The environmental assessment PO 4.01 (EA) of projects considered for attribution of fund from the World Bank aims at ensuring that these projects are environmentally sound and sustainable, and thus to improve the process of decision-making. The EA is a procedure whose extent, depth and type of analysis depend on the nature and the scale of the project under consideration and the impact that it is likely to have on the environment. It consists in evaluating the risks which the project can present on the environment and the effects which it is likely to exert in its zone of influence, to analyze the possible alternatives of the project, to identify the means of improving the selection of the project, its localization,

its planning, its design and its execution while preventing, minimizing, attenuating or compensating for its negative effects on the environment and reinforcing its positive effects. The EA takes into account the natural environment (air, water, soils); health and safety; social aspects (involuntary resettlement, indigenous populations, and cultural property) and general environmental aspects. The natural context and the social context are integrated. In this context, it is not very likely that significant and/or irreversible environmental impacts will occur. Nevertheless, the projects must highlight these minor environmental impacts which will be evaluated and attenuated with through the environmental management plan.

- The policy relating to the conservation of the "natural habitats" (PO 4.04) is applicable every time a change or a significant degradation of the natural habitats, directly (through construction) or indirectly (through human activities induced by the project), can be identified. The Bank does not support operations implying a change or a significant degradation of critical natural habitats. Procedure of environmental assessment (PO 4.01) must identify all the critical natural habitats in the area of influence of a project. For other natural habitats, the Bank does not support the projects generating significant degradations unless there is no alternative solution to limit the impacts and that additional analysis showed that the benefit of the project will be substantially higher than the environmental effects. If the project converts or degrades the natural habitats significantly, suitable measures acceptable to the Bank, aiming at reducing the effects of the project, must be planned so as to maintain an ecologically protected sector.

- The policy relating to the "safety of dams" (PO 4.37) requires that only qualified professionals can supervise the design and the construction of a new dam. Because of serious consequences which may rise from a malfunction of a dam, the Bank has strong concerns about the safety of new dams and existing dams. The Bank can finance various types of projects not only comprising dams but also projects which depend on the good state of an existing dam or a dam under construction.

- The policy related to the "pest management" (PO 4.09) insists on the use of biological or environmental methods and limits the use of chemical pesticides. During the evaluation of a project, the Bank identifies the lawful framework in place and local institutions to determine the likelihood to promote and facilitate the adoption of safe methods.

5.3 Short description of the project and main environmental and social components

1.1 EDG's project is divided into three : i) CREST (Commercial Reorientation of the Electricity Sector Toolkit) in order to improve the distribution network, the quality of the electricity sector, customers' satisfaction, and to reduce the electricity losses; ii) rehabilitation of Garafiri hydroelectric power plant and the thermal power plant of Tombo to increase the electricity output; iii) promotion of better management of energy demands, promotion of private sector involvements (investments; management practices), assistance to EDG to improve their management capabilities (technical and financial).

1.2 The main environmental and social aspects concern the monitoring of the implementation of environmental measures, awareness regarding environmental protection, measures to restore land, environmental protection and management, measures to improve the framework and populations' livelihood.

1.3 It should be noted that this project does not involve the construction of a new power station, but rather concerns the rehabilitation of existing hydroelectric and thermal power stations, in order to improve the production and the distribution of electricity. This rehabilitation will aim at improving technical installations and will not induce any expropriation or require new constructions.

1.4 The main environmental issues concern the management of liquid and solid wastes (used oils, containers, industrial and special waste ...), the management of air emissions, the contamination of soils as well as safety aspects (health risks...).

1.5 Based on the size of this project and the nature of potential sub-projects, the location of the project in areas of low sensitivity (regarding the environment and the environmental effects easily managed by the implementation of adequate measures), the project would be classified in Category B according to the environmental assessment policy of the World Bank (OP 4.01), requiring a framework for environmental and social management. The evaluation of the environmental conditions carried out during the site visits indicates that the area directly affected will be limited to the accesses of the power stations and their close surroundings; the recommended measures will attenuate the negative impacts.

5.4 Screening of impacts and main environmental and social impacts

5.4.1 Screening of impacts

- For each project suggested, the identification of the impacts is the first environmental prior examination to determine the range of environmental assessment and the type of instrument to be used for the EA.
  The process of environmental identification of the World Bank consists in classifying the projects in three categories:
  - category A: projects which require a complete environmental assessment;
  - category B: projects with potential adverse environmental effects which require a partially environmental assessment;
  - category C: projects with minimal effects on the environment, which do not require an environmental assessment.

  The details of the identification procedures are described in the operational policy of the World Bank (OP 4.01). Category A projects are likely to have very negative impacts. These effects can affect a zone broader than the sites or the installations studied.

  Category B projects can have specific impacts on the site without significantly affecting the populations or the environmental zones including marshy lands, local forests, natural meadows, and other habitats.
  A project for which the negative effects on the environment are considered as small or insignificant must be classified as category C projects.

  The World Bank classified the project under category B, implying that partially environmental assessments should be carried out.

- Criteria of this identification were developed at two levels:
  - criteria relating to the sensitivity of the potential impacts on the environment;
  - criteria which bind to nature and the significance impacts of project.

  The two categories include environmental, social and economic criteria. With regard to the criteria of identification, a condition for the EA or the complete EIA should be given according to nature and the classification of the impacts, if the project would be localised near environmentally critical areas, which are:

  - protected sites, reservoirs, sanctuaries and habitats;
  - in or near significant ecosystems such as marshy lands, mangroves, coral reefs and habitats of endangered or threatened species, and more particularly endemic species;
  - specific zones retained for aesthetic and recreational uses;
  - in or near zones of archaeological interest sites and/or historical or cultural and social interests;
  - in over-populated zones where population resettlement may be required or where the impacts of potential pollution and other disturbances can affect the communities significantly;
  - in the areas prone to large development activities or where there are conflicts in the attribution of natural resources;
  - on soils or waters comprising resources (such as fishing, medicinal plants, agricultural lands etc.); and
  - areas frequently concerned and/or seriously damaged by natural disasters including: chronic storms, erosions, sudden rises of storm, and floods.

EDG's project is not located in any of the environmentally critical areas listed above.

- The following criteria can be used to determine if a given environmental impact is SIGNIFICANT:
  - Physical extent of the impact (site, island, atoll, or national);
  - Extended in the time of impact (short, medium, or long term);
  - type of change of the environmental parameters caused by the activities of the project (small, moderate, large);
  - importance of the affected parameters on local populations (for example: fish for their consumption, drinking water, agricultural products);
  - national or international profile of the affected parameters (for example: rare and endangered species);
  - probability of occurrence of a specific impact; cumulated impact of the project's activity and other activities planned or in progress; or
  - if deterioration occurred since the design of the project, and if it involved negative impacts, they will evaluated as impacts due to project's development (for example: evaluation of halieutic stocks).

- An activity will be considered to have NO IMPACT if the environmental parameter is physically removed in space or time. If an impact occurs, but does not meet the criteria for significance, it is evaluated as INSIGNIFICANT. The potential impact of an activity will be evaluated as UNKNOWN if:
  - the nature and the localization of the activity of project are dubious;
  - the occurrence of the environmental parameter in the localization of the project is dubious;
  - the duration of the effects is unknown;
  - the space extent of the effects is unknown; or
  - the extent of the effects cannot be evaluated.

  In such situations, more analysis will be required before taking any decision on the level of the impacts.

- The potential impact of an activity on an environmental parameter will be evaluated as ATTENUATED, if there is a significant potential impact; and suggested attenuation measures will prevent the impact or lower the impact to acceptable levels.

5.4.2 Main potential impacts

A general list, shown in the table below, was drawn up in order to satisfy the following objectives:

- to precisely identify the environmental and social impacts and related actions;
- to identify measurements of attenuation or reduction of the project's impacts;
- to identify the indicators to monitor the implementation of the measures.

Site	Item	Actions	Comments
TOMBO power plant	Findings of the 2003 & 2004 audits	Water treatment, ground pollution	The recommended solutions were not implemented.
	Safety	Fire protection	In case of a fire, populations present in the vicinity of the site could be affected.
	Water management	Quality monitoring of rainwater and wastewater	The issues associated with water management will only be solved once: - solutions recommended in the former studies of 2003 and 2004 (mainly repair/replacement of parts/equipments) are implemented - awareness of the personnel on better environmental management is improved
	Air emissions	Quality monitoring of air emissions	Initially, we would recommend the quality of the air emissions at exit of the exhaust pipes to be evaluated, in order to assess the impact of the groups on the air quality.
	Hazardous products	Implementation of a management system for hazardous products (storage, disposal etc.)	Many hazardous products are present on the TOMBO site ; however, their management is inadequate or inexistent (lack of retention, leaks, etc.). A such, the issue associated with the management of hazardous products will only be solved once the solutions recommended in the previous studies of 2003 & 2004 are implemented: mainly repair / replacement of parts / equipments, and personnel's awareness on improving environmental management practices, and on the impacts generated by the site.
	Waste	Implementation of a management system for waste	The issue associated with waste management is closely linked to the air and water management issues. As such, it cannot be solved until the solutions recommended in the previous studies of 2003 & 2004 are implemented: mainly repair / replacement of parts / equipments, and personnel's awareness on improving environmental management practices, and on the impacts generated by the site.
	Remediation of existing pollutions	Implementation of a remediation program to treat the pollutions identified in soils and natural water (lacks etc.)	As long as the solutions recommended in the former studies of 2003 and 2004 (mainly repair/replacement of the parts/equipment) and adapted awareness / training are not implemented, the risks of pollution of the environment will continue to exist.
	Noise levels	Evaluation of noise levels generated by the power plant	We would recommend the monitoring of noise emission levels inside and outside the buildings in order to determine the impact of the activities on site personnel and nearby populations.
	Health & safety	Training of employees	Employees must be trained as rescuer/first-aid workers and have regular recycling.
	Health & safety	Information of populations	The nearby populations must be informed of the dangers related to the activities of the TOMBO site, and know how to react in the event of major accident (fire). Thus, EDG must set up an adequate procedure.
Hydro power plants and associated dam	Environmental impact	Evaluation of environmental impacts	
	Socio-economic background	Evaluation of the impact of the Garafiri project	The recommendations stated in the 2003 impact study must be implemented

This table presents for all the sites the impacts identified and potential measures to adopt. This constitutes a first flexible and easy to use approach. The expected impacts which could be caused by the rehabilitation of the power stations are listed and evaluated according to their nature, extent, importance and sensitivity of the receiving environment. This is based on available data and information. The number of actions to be taken and environmental indicators can increase or decrease according to the results' of the environmental and social impact studies which will be undertaken.

5.5 Code of good environmental practices

The environmental codes of practice to be implemented on the sites are described below; they concern 2 categories:

- power station for the production of electricity:
  - hydroelectric
  - thermal
- water dams and reservoirs.

These codes of practices are elaborate while following the recommendations of the World Bank published in "pollution prevention and abatement handbook".

For all the installations, an evaluation of the environmental situation is necessary taking into account the classification of the project.

Impact study for the activities:

An impact study was only carried out for the hydroelectric power station of Garafiri and its dam before their construction. No particular study of the social and environmental impacts of other sites was ever carried out. Therefore it seems convenient to carry out now an evaluation of the environmental and social impacts of the 3 hydroelectric power stations as well as associated dams and power stations.

These impact studies, due to the lack of data on the original state of the sites, will only consist in a thorough environmental audit essentially highlighting the data presented in the first part of this report (audit of the sites). A ground investigation should be undertaken to undertake the actual state of the sites and to be used for future monitoring of the sites.

This requires a detailed analysis of the environmental aspects likely to be impacted by the activity. It is also of prime importance to determine the geographical limits of the impacts of the project by preparing maps of sensitive areas around the site.

It is very important to determine the impact of the site operations in their existing layout and to appreciate the positive effects expected once the installations comply with the regulations.

This environmental assessment could be carried out at the Garafiri plant and dam to measure the actual impacts of the project compared to the original data and to allow the implementation of corrective measures.

All the critical points identified at the time of these studies will have to be included in the rehabilitation project and the environmental management plan. It is essential to have an evolutionary approach on environmental and social aspects in order to adapt it to local conditions.
In the same manner, the incidence of the environment on the project will have to be studied thoroughly in particular the issues related to the silting of the reservoirs due to the erosion of the lands located upstream (deforestation) or related to the abrasion of the machines by the action of the silts contained in the water of the dam.

This approach will allow a better control of the investments carried out for the repair of the installations.

5.5.1 Power station for electricity production

5.5.1.1 Waste management

The waste generated by the power stations are typical of combustion units. The main sources of pollution are the air emissions and the liquid waste (effluent).
In the hydroelectric units, only a good liquid & solid waste management program may limit considerably the environmental impacts.

Air emissions:

These recommendations relate to thermal power station only:

The main air emissions from the power station (fuel-fired) are:

- SOx and NOx;
- VOCs.

NOx and VOCs are compounds contributing to the greenhouse effect and depleting the ozone layer.
The environmental management plan will consist in:

- an optimization of the burners and modes of combustion;
- a selection of fuel with low sulphur content;
- regular monitoring of air emissions through an automatic device for sampling and analysing;
- similarly, a regular monitoring of the air quality will have to be undertaken within the vicinity of the power station.

The power station being located in an urban context, an analysis of health risk for neighbouring populations due to atmospheric emissions must be carried out. In particular, a computer simulation of the dispersion of the emissions should be carried out.

Solid waste:

A sorting of the waste generated by the installation should be implemented. A differentiation between ordinary waste (not soiled) such as wood, paperboards, scrap... and soiled or toxic waste (used barrels, oils, fabric, solvents...) must be carried out at the production sites. Waste will be quantified and disposed off to existing landfills and controlled (in particular toxic waste).

Liquid waste:

- ***Cooling Water treatment***

The cooling waters of the thermal power station will be treated. The existing SEREP must be repaired.
Regular analyses will be carried out in various points of the water network:

- upstream (feeding water),
- exits of the various groups,
- input of station,
- output of station.

The analyses will be carried out regularly (daily) and deferred on a register.

- ***Rain water management***

Rainwater is actually soiled by hydrocarbons. Taking into account strong precipitation in Guinea, it is not possible to treat the effluents in a treatment plant. Also, we suggest the installation of a retaining tank for this water with a hydrocarbon retention device in order to minimize the discharge of effluents in the natural environment.

Finally, a regular monitoring of the quality of water discharged must be carried out in order to implement adequate corrective measurements and rehabilitation if necessary.

Ground remediation:

Several points appeared at the time of the audits regarding potential hydrocarbon ground pollution. The induced risk lies in a possible pollution of the aquifers under unclaimed which it will be necessary to supervise by the installation of piezometers upstream and downstream of each group with water sampling for laboratory analyses.

With regard to the site users, there is a health risk associated with skin contacts with the products. Remediation of these grounds (excavation, containment) is required to limit this risk.

In the future, when the power stations will be operated, all necessary provisions will have to be taken to prevent any risk of pollution of the grounds: placing oil drums on adequate retentions; construction of impermeable covers.

5.5.1.2 Reservoirs

Management of water quality:

The quality of the water contained in the reservoirs must be assessed regularly by the owner as this water is used as the drinking water supply for nearby villages. Moreover, the water quality, especially the suspended solids content, may present a risk in the medium / long term by reducing the useful volume of the reservoir due to silting. Additionally, it may indicate other problems such as corrosion of the equipments due to the abrasive effect of the suspended solids.

A fast degradation of the water quality can occur if significant wastewater discharge occurs in the reservoirs. An eutrophication of the water can occur and increase fish mortality and reduce water potability.

A preventive management of the water quality involves the knowledge of operations carried out upstream of the catchment area.

Management of sediments in order to optimize and to limit their impacts:

An impact study will have to be carried out for any dragging project.

Regular campaigns will be carried out to determine the level of silting in the reservoirs. Dragging campaigns are major works which need to be programmed in advance.

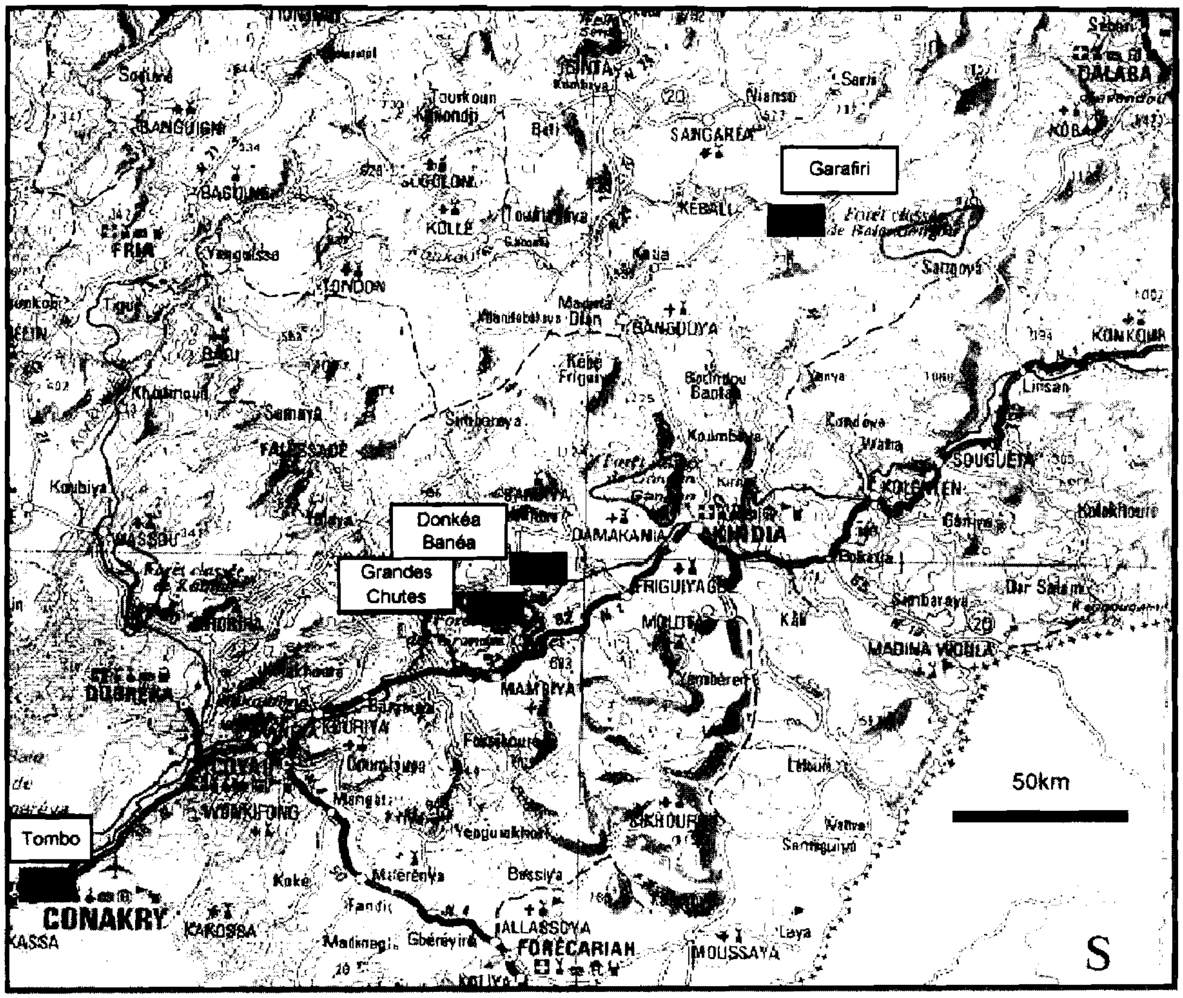
Monitoring of the ecosystem:

A monitoring plan for alluvial aquatic ecosystems must be set up upstream of the sites and also downstream. An analysis of the impacts of the water discharges must be carried out.

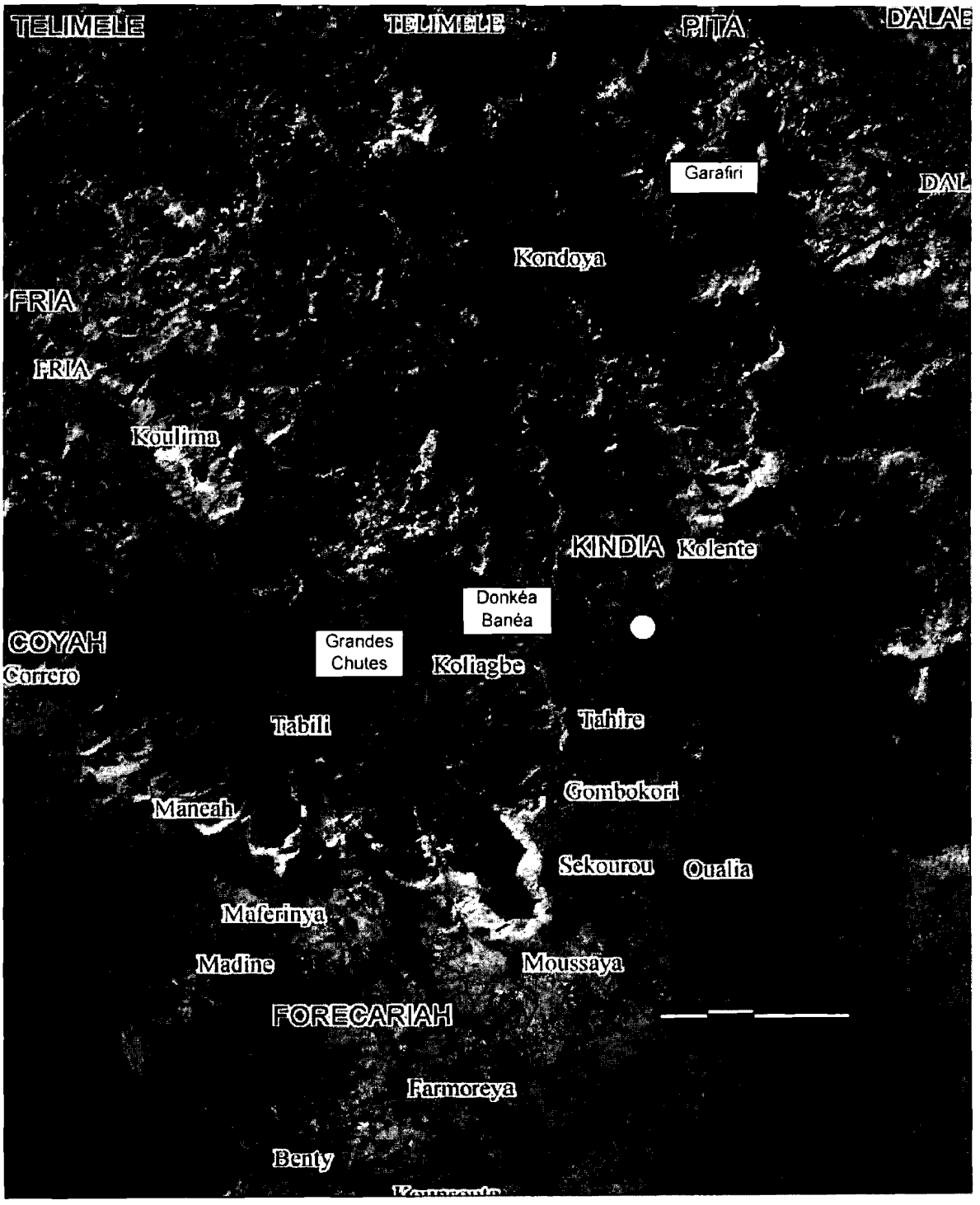
Similarly, the definition of a minimum reservoir flow must be undertaken so that quality of the aquatic ecosystems remain unchanged for populations located downstream of the dams. To date, there is no management of water quantity downstream of the dams. An estimate of the impacts generated is to be predicted.

APPENDICES

- Appendix 1 -
Sites location map


Garafiri
Donkéa Banéa
Grandes Chutes
Tombo
50km
CONAKRY
KINDIA
FORECARIAH
S

- Appendix 2 -
Hydroelectric power plants location map


TELIMELE
TELIMELE
PITA
DALAB
Garafiri
DAL
Kondoya
FRIA
FRIA
Koulima
KINDIA
Kolente
Donkéa
Banéa
COYAH
Grandes
Chutes
Correro
Koliagbe
Tahire
Tabili
Gombokori
Manéah
Sekourou
Oualia
Maferinya
Madine
Moussaya
FORECARIAH
Farmoreya
Benty

- Appendix 3 -
EDG environmental policy

ENVIRONMENTAL POLICY LETTER

Electricité de Guinée (EDG) is a public company whose main missions are as follows:

- the guarantee of a public service for electricity delivery
- the management and the development of the electrical heritage of Guinea
- the exploitation and the distribution of electricity to the entire territory of Guinea.

In order to do so, the company uses all practical means to protect and emphasize the environment.

Due to the nature of its installations and equipments, and due to the type of product EDG delivers, EDG has decided to fully accept the environmental liabilities associated with its activities.

Principles

EDG's management team commits itself to respect environmental rules in the design and implementation of all its programs.

EDG will manage the environmental implications of its activities at the source by the use of techniques, products, procedures and research to improve working and management methods.

EDG will comply with applicable national laws, regulations and policies as well as specific agreements, and will establish its own regulations if required.

The protection and the highlight of the environment are now part of EDG employees' and partners' main concerns.

To this end, EDG invite all its employees, sub-contractors and clients to participate, and be committed to the success of this policy.

- Appendix 4 -
Photographs and layout of Grandes Chutes

- Appendix 5 -
Photographs of Donkéa

- Appendix 6 -
Photographs of Banéah

- Appendix 7 -
Photographs and layout of Garafiri

- Appendix 8 -
Photographs of TOMBO

- Appendix 9 -
Summary tables of Garafiri environmental impacts (extract from the EIA of 1993)

- Appendix 10 -
Status of electricity production groups on 12th December 2005

- Appendix 11 -
Power graph for 25th December 2005

- Appendix 12 -
EDG Environmental Department Directives

- Appendix 13 -
EDG environmental action plan

- Appendix 14 -
List of people interviewed

Liste of people interviewed

- Kalil Diallo In charge of Planification & Equipements
- Sekou Fofana In charge of the Environmental Department (EDG)
- El Hadj Aboubacar Diakité In charge of the Equipment Departement
- Halphy Diallo Technical Advisor
- Thierno Oumar Barry In charge of the Planification Departement
- Abdoul Rachid In charge of the Equipment Department
- Oumar Diong In charge of Human Resources
- Mamadou Diakité In charge of Social Services
- Ibrahima Sory Traoré In charge of the Training Department
- Dr Halimatou Tandeta Diallo, Ministry for the Environment
- Ibrahima Camara In charge of the Thermal Department
- Oumar Bah In charge of the Hydraulic Department
- Lamarana Baldé In charge of the technical section of the Thermal Department
- Massoud Stocks' manager
- Aguibou Kaba In charge of Grandes Chutes power plant
- Oumar Tély Bah Maintenance section (Grandes Chutes power plant)
- Alpha Amadou Diallo In charge of the operating section (Grandes Chutes)
- Salifou Bangoura In charge of Donkea power plant
- Aboucar Soumah In charge of Donkea operating section
- Mamadou Tounkara In charge of Garafiri power plant
- Saidou Sangaré In charge of Garafiri maintenance division
- Mamadou Bailo Diallo In charge of Garafiri operating section

- Appendix 15 -
List of documents reviewed

The following documents were reviewed during the course of the audit

- Code de l'électricité
- Code de l'eau
- Code de l'environnement
- Loir sur le BOT
- Statuts d'EDG
- Projet hydroélectrique de Garafiri – avant-projet environnemental et réinstallation des populations réalisé par BCEOM
    - Tome A- synthèse de l'étude d'avant-projet détaillée (Garafiri) – December 1990 -
    - Tome B – Actualisation de l'étude d'avant projet détaillée (Garafiri) – September 1993 –
- Actualisation de l'étude environnementale du projet de Garafiri (rapport final) réalisée par BCEOM – March 1994 –
- Rapport final de l'étude d'impact du barrage de Garafiri sur le bassin versant de l'estuaire du Konkouré par le groupement IRD / BCEOM / BRLi, Tomes 1 & 2 – février 2003 –
- Etude environnementale de la Centrale de Tombo par le Service Environnement d'EDG – 2003 –
- Etude diagnostic du système de collecte et de traitement des effluents de Tombo par ECS –April 2004 –
- Evaluation de la charge polluante des effluents résiduaires des centrales thermiques de Tombo et mesures d'atténuation des impacts sur l'écosystème et sur la santé humaine réalisée par la direction nationale de l'environnement – August 2003 –
- World Bank environmental and social safeguard policies (August 2005)