

## **APPENDIX 01: BIBLIOGRAPHY**

## **Bibliography**

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## **ANNEX 02: TERMS OF REFERENCE**



**Ministry of Environment  
and Rural Development**

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**Directorate of the Environment  
and classified establishments**  
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Dakar, JAN 15. 2018

**The director**  
**AT**  
**Mr. Bassirou SYLLA**  
**Quality, Safety and Environment Director**  
**National Electricity Company**  
**(SENELEC)**

**DAKAR**

**Subject:** Validation of the terms of reference for the environmental and social impact study of the project to build the 120 MW thermal power station in MALICOUNDA (Thiès region)

**Ref:** Letter n ° 01-11-17 / DQSE / SE / IG of November 15, 2017

Mister Director,

I acknowledge receipt of the correspondence transmitting the terms of reference for the environmental and social impact study (ESIA) of the above-mentioned project.

Please find attached the observations of the Directorate of Environment and Classified Establishments (DEEC) on the said terms of reference (TDR)

DEEC gives its agreement for the start of the study subject to the inclusion of these points in the terms of reference. For this purpose, please send us a copy of the finalized TDR.

In addition, for the purposes of the authorization procedure for classified installations, I kindly ask you to contact the Division of the classified installations without delay, located on the 3rd floor of DEEC at 106 Carnot street in Dakar.

As a reminder, the amended TDR should be annexed to the ESIA report.

Please accept, Sir, the assurance of my highest consideration.

**Annex:** Observations of the DEEC on the TDR of the ESIA for the project of the realization of the thermal power plant of 120 MW, in MALICOUNDA

**Mariline DIARA**

Amplification:

- ☐ MEDD (ATCR);
- ☐ DIC (for information);
- ☐ DCPN (for information);
- ☐ DREEC / TH (for information).

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**Ministry of Environment  
and Rural Development**  
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Dakar, JAN 15. 2018

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**Directorate of the Environment  
and classified establishments**

Observations of the Directorate of the Environment and Listed Establishments on the Terms of Reference of the Environmental and Social Impact Study of the project to realize a 120 MW Thermal Power Plant in MALICOUNDA

After examining the document and the site visit carried out on Monday, November 27, 2017, the Directorate of the Environment and classified establishments (DEEC) asks you in addition to the comments contained in the terms of reference submitted, to focus on the following:

➔ **General scope of the ESIA**

The analysis from the point of view of the identification and evaluation of the impacts will be done on the basis of the phases, achievements and activities of the project.

The project phases, defined for the needs of the ESIA are as follows:

- Preparation: installation of the site base and routing of equipment, materials and equipment;
- Works: construction and installation of equipment;
- Operation: loading, unloading, auxiliary operations, equipment maintenance;
- End of life of the installations;
- Etc.

➔ **Description of the project and its associated facilities**

A precise and detailed description of the following elements of the project must be presented:

- the project developments;
- the nature and importance of infrastructure and superstructure works;
- pre-construction and construction activities;
- excavation and embankment activities;
- the nature and extent of the site equipment (essential for determining impacts during the work phase);
- necessary maintenance work and off-site investments;
- the staff mobilization plan;
- the organizational and technical capacities planned to take charge of the HSE aspects during the different phases of the project and/or any other arrangement planned with specialized structures;

- applying the best available techniques and best environmental practices;
- etc.

Add maps to relevant scales (format A2, A3 at 1/25,000 scale), plans and diagrams related to the various project infrastructures, to the land use around the various infrastructures/structures by materializing areas of socio-environmental sensitivity.

#### ➔ **Legal and institutional framework**

The study should describe the legal, legislative and regulatory framework that frames the project. To this end, the texts applicable to the planned activities must be identified and analyzed in terms of their relevance for the said activities. The consistency between these texts and the project will have to be analyzed.

If applicable, the relevant provisions of the Environment Code, the standards for rejection and emission, the ICPE regulations, and the health and safety texts applicable in Senegal should be taken into consideration.

When aspects are not regulated by national texts, international regulations and standards must rule in the analysis, in particular the performance standards of the International Finance Corporation (IFC).

The consultant will identify the main national and local institutions, directly or indirectly involved in the project. He will review their mandates and capacities to suggest a capacity building program.

#### ➔ **Description and Analysis of basic environmental and social conditions**

##### ➤ **Preliminary delamination of the study perimeter**

The consultant will define the project area of influence. On this basis, he will analyze the initial state of the environment. This perimeter must be wide enough to cover both direct and induced effects.

The reasons for the choices made on the delimitation of the scope of the study must be explained and justified. This delimitation must be illustrated on a topographic map.

##### ➤ **Analysis of the initial state of the host environment**

The consultant will analyze the evolution of the environment and the evolution of its sensitivity. It is a question of studying the evolution of the environment without the implementation of the project and then of assessing its sensitivity, this will help to highlight the environmental and social components which will be most affected by the realization of the project.

The consultant shall specifically:

- make a complete analysis of environmental and social sensitivity following the description of the receiving environment by stressing on its socio-economic vocation

- hydrology (describe any change in the water balance that may be introduced with the station's cooling cycle);
- water quality (describe the effluent discharges from the installation and their final outcome);
- industrial risks and emergency measures (i.e. risk of fire or explosion depending on the type, source and storage of fuel);
- health and safety for employees at work;
- the impacts on accessibility (access routes leading to the site) and current and planned use of the site;
- The economic impacts associated with the development and operation of the facilities/structures (possibility of employment or contract, etc.)
- effects on the visual environment (intrusion of new elements into the visual field and change in the aesthetic quality of the landscape);
- nuisance caused by noise, dust, odors and heavy transport during the construction period;
- any obstacles or disturbances to the movement of vehicles and people and to activities that may arise;
- the acquisition of rights of way and easements;
- destruction of vegetation and cutting down of trees;
- the loss of agricultural activities and income in favor of the population;
- loss of land for residential use or restriction of property rights;
- modification of water bodies;
- the different types of nuisance during the line installation phase;
- risks of work accidents and electrical risks;
- disruption of migratory movements or displacement of wildlife;
- the risk of disappearance of threatened or vulnerable flora and fauna, of heritage or commercial interest;
- the risk of electric shock and fire linked to the transport of electrical energy;
- the impact of the works on the natural and cultural heritage (destruction of natural resources, removal of graves, cultural sites such as places of worship and sacred forests);
- the destruction or relocation of the built heritage;
- impacts on public or community service infrastructures such as roads, intakes and water points, etc. ;
- etc.

In order to better see the effects of the project on the environment, an identification table of impacts by project period (site, commissioning) indicating the affected environments must be presented.

After identifying the impacts of the project on the environment, the study must include a qualitative and/or quantitative evaluation of these direct and indirect effects by location and situation over time (period, duration, and frequency) and estimation of the probability of occurrence.

In a natural environment, the identified impacts will be assessed based on the initial state of the recommended generating action. Depending on the importance of the impacts, the use of modeling is recommended in order to determine the spatial extent of the impact.

Regarding emissions, on the basis of a reference air quality situation, the consultant will have to proceed with a modeling of the dispersion of the different emissions of the project in order to determine the impact (spatial extent) of these emissions with the different zones likely to be affected as well as the values (concentrations) expected in each zone. The models as well as the parameters to be modeled must be justified.

In addition, in his impact analysis, the consultant will have to put particular emphasis on the determination of the safety zone between the project facilities and the human occupation zones and on all the factors/elements that can cause a cumulative effect and draw any conclusions or recommendations.

**NB:** the impact analysis and the danger study must take into consideration all the project components (the power station, its auxiliaries and attached components).

#### ➡ **Waste management**

The consultant will identify:

- The different types of waste produced by the project during the construction phase and the operation phase;
- The impacts of waste on populations and the environment;
- Waste management methods and measures;

#### ➡ **Danger study**

This danger study (EDD) must be carried out in accordance with the Methodological Guide to the Danger Study of the Ministry of the Environment:

The Consultant must pay attention to the site environment and consider it as an external source of danger for the installations. He will have to provide:

- an analysis of the risks linked to the works;
- an analysis of natural risks which could impact the installations/structures;
- an exhaustive analysis of professional risks;

The consultant will provide information on the best choice for the location of the site base from the point of view of the various risks, taking into consideration the measures of mitigation identified, as well as the location of the different installations to reduce the risks, especially in relation to the HT lines, national road, the AGEROUTE base station, etc.

This EDD must provide the elements allowing the realization of a POI in the operational phase. To this end, all dangerous phenomena deemed unacceptable must be the subject of modeling on a cartographic background and on a scale allowing to identify the installations or areas that may be impacted.

This modeling should also allow to determine the safety distances to be respected between the site limits and neighboring occupations as well as the safety barriers to be put in place.

All of the measures set out in all of this EDD to reduce risk will need to be justified.

#### ➡ **Environmental and Social Management Plan**

The environmental and social management plan (ESMP) must define the measures that will be taken by the Contracting Authority to eliminate, reduce if possible, and compensate for the damaging consequences of the Project on the environment.

The measures taken by the Contracting Authority must be clearly defined. This definition will include:

- a detailed description of the measure;
- the conditions of application (timing) and mobility of this measure;
- a designation of the body implementing this measure.

Ultimately, the ESMP will present the measures provided for the different phases for carrying out the works and commissioning the infrastructure, to eliminate or reduce the negative impacts of the project.

The study should define the considered measures to promote or improve the positive impacts. It will present an evaluation of the effectiveness of the mitigation, compensation and improvement measures for the identified impacts. The ESMP will also be presented in the form of a summary table with the main results and recommendations of the ESMP, the impacts and attention measures, the costs associated with each mitigation measure as well as the responsibilities for implementation.

The ESMP must include a detailed plan for the dismantling and rehabilitation of all areas disturbed by the project, as well as the entire strategy for managing pollution and accidental spills.

#### ➡ **Environmental monitoring and follow-up plan**

The consultant will propose an Environmental Monitoring and Follow-up plan which should indicate the links between the impacts identified and the indicators to be measured, the methods to be used, the frequency of measurements and the definition of threshold causing the corrective measures. The monitoring plan should be sufficiently detailed and should clearly identify the monitoring parameters and the costs relating to monitoring activities.

The purpose of this follow-up program is to ensure that the mitigation measures are effectively implemented, that they generate the expected results and that they are either modified or canceled if they do not produce satisfactory results.

Environmental monitoring and follow-up reports should be scheduled at all stages of the project to verify the level of implementation of the mitigation measures and assess the effects of the works on the environment.

#### ➡ Environmental clauses to be inserted in the DAO

The consultant will have to propose specific recommendations to the companies carrying out the works for the protection of the environment, which directives will have to be inserted at the level of the technical specifications allowing the respect and the protection of the environment during the execution of the site.

#### ➡ Environmental assessment of the project

The study must present a conclusion of the impact study identifying the major risks of the project on the environment, the effectiveness of the measures proposed and the benefits of carrying out this project.

#### ➡ Capacity building plan

The consultant will have to assess briefly the capacities of the technical services to make the environmental follow-up of the project and the needs of reinforcement of these services for a correct implementation of the ESMP.

To this end, he must therefore prepare a summary budget of all the actions and activities proposed.

#### ➡ Validation

The consultant will provide SENELEC with the provisional report of the study in twenty-five (25) copies in addition to an electronic copy (PDF format) for saving it at the Department of Environment and Listed Establishments (DEEC), which will summon the members of the Technical Committee to a pre-validation meeting to be held in Thiès.

Following the pre-validation, the promoter in contact with the local community, the consultant and the support of the DREEC, will organize a public hearing session for MALICOUNDA commune hosting the project, in accordance with the provisions of the Code of the environment of Senegal and its implementing texts.

The final study report, after integrating the observations, will be submitted in seven (07) copies to DEEC, in addition to an electronic copy (PDF format).

#### **NB: Recommendations**

1. If the project must require **the displacement of populations**, the consultant must draw up a **Resettlement Plan for displaced populations** which describes the measures to be taken in order to compensate for the economic and social impacts that may result from involuntary displacement, loss of property or access to property, or loss of income or livelihood. This Resettlement Plan, if necessary, should be a separate document from the environmental impact study.
2. The study must list the classified installations referred to by the Nomenclature of Installations for the Protection of the Environment and expected to be used within the framework of this project with their classification regime.

3. The study will have to take into consideration all the projects in progress or expected in the area. Therefore, the consultant will have to provide a clear mapping of the land use around the project.
4. The study must provide information relating to end-of-life installations



## **ANNEX 03: PUBLIC CONSULTATIONS**

## **List of consulted stakeholders**

### **3.1 At the local level**

- Municipality of Malicounda;
- Village of Malicounda Wolof;
- Village of Malicounda Bambara;
- Village of Malicounda Sérère;

### **3.2 At regional and departmental levels**

- Governance of Thiès;
- Prefecture of Mbour;
- Sub-prefecture of Sindia;
- Departmental Council of Mbour;
- ARD of Thiès;
- Mbour land registry office;
- Mbour Hygiene Brigade;
- Regional Labor and Social Security Inspectorate;
- Regional Division of the Environment and Listed Establishments of Thiès;
- Firefighters of Thies;
- Regional Planning Service;
- Regional Sanitation Service of Thiès;
- Regional Department of Mines and Geology of Thiès;
- Departmental Service of Town Planning;
- Regional Division of Hydraulics of Thiès;
- Thiès Regional Development Agency;
- Regional Department of Statistics and Demography of Thiès.

### **3.3 At the national level**

- AGEROUTE;
- Regulatory Commission for the Electricity Sector (CRSE);
- Directorate of Industry;
- Department of Environment and Classified Establishments:
- Environmental Impact Assessment Division;
- Pollution and Nuisance Prevention and Control Division;
- Air Quality Management Center;
- Directorate of Water Resources Management and Planning (DGPRES);
- Directorate of Civil Protection;
- Electricity Department;
- SAR.

Public consultation with AGEROUTE as part of Malicounda thermal power station construction and operation project.

**Date:** Monday July 10, 2017

**Start time:** 10:20 am

**Duration:** 45 minutes

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Present

-AGEROUTE

Mr. Babacar Ngom: Environment and Social Unit

Ms. Amie Nd. Goumbala: Sociologist

-EES cabinet

Malick DIALLO

Mintou NDIAYE

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**Agenda:**

1. Opening remarks and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the project**

- The responsible want to have the compass rose to know the orientation of the fumes coming from the power station, which harm users of toll highway;
- For this work, AGEROUTE plans to install 04 boreholes;
- In the construction phase, good communication with the population and good coordination with existing businesses will be necessary;
- If power lines must pass through the toll highway, these must be underground;
- An interchange is planned in the Malicounda area. Mr Ngom put us in contact with AGEROUTE project manager, Mr. Mamadou Moustapha Dème, who will be responsible for indicating the limits;
- As the installation of the base station has already been carried out, construction work is therefore imminent.

**AGEROUTE's expectations and recommendations**

- Provide the passage of underground power lines at the toll level;
- Diversify the compensation measures for the populations such as the employment of local labor, the electrification of the area and the creation of projects for the populations;
- Provide an easement zone of at least 500 m between the plant facilities and the toll highway;
- Communicate with the population during convoys to transport construction materials;

- Notify AGEROUTE and set up a communication plan for the transportation of construction materials and the dismantling of walkways;
- Transport heavy materials preferably at night;
- Consult DGPRES to ensure that the water resources in this area will be sufficient for the creation of boreholes for AGEROUTE and for the power station project, while taking into account the needs of the populations.

Public consultation with Thiès Regional Sanitation Service as part of the construction and operation project for the Malicounda thermal power station.

**Date: Tuesday July 11, 2017**

**Start time: 09h18mn**

**Duration: 01 hour**

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**Present**

-Regional Sanitation Service of Thiès

Mr. SONKO: Head of service

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the Project**

- There is a treatment plant in Mbour and another in Saly;
- If the waste water from the power station contains non-treatable substances and is very loaded, it is imperative to set up a WWTP;
- Noted that the dimensions of a WWTP are determined from the volume of discharged water.

**Expectations and recommendations of Thiès Regional Sanitation Service**

- See if the station can connect to Mbour treatment plant or provide a WWTP or a lagoon system;
- Provide toilets according to gender and taking into consideration people with reduced mobility and menstrual hygiene;
- Set up toilets with boxes of 07 people taking 5 per toilet: the sanitation service has plans for construction and management model for these types of infrastructure;
- Train staff on the sanitation ladder (teach them what to do or not to do).

Public consultation with Mbour Cadastre Office as part of the Malicounda thermal power station construction and operation project.

**Date:** Tuesday July 11, 2017

**Start time:** 11h00mn **Duration:** 01 hour

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Present

-Office of the Cadastre of Mbour

Mr. Aliou DIOUF

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment

**Opinion and perception on the Project**

- It should be noted that the law of 1964 which governs the national domain stipulates that after a period of two (02) years without development, an affected land can be decommissioned and reassigned;
- For a reason of public utility, the choice is unequivocal on the station project;
- The procedure should be speeded up in order to secure the land acquired by deliberation.

**Expectations and recommendations of the Mbour cadaster office**

- Make a statement on the current situation of the site;
- Come closer to the cadaster to make a statement on the encroached area;
- Come closer to the state commission to be built on the issue of land occupation (subdivisions);
- Materialize the property base with stakes, terminals or tables or fence the site with barbed wire;
- Formulate a lease request at the Domains level and request the final session once the lease that has been acquired.

Public consultation with the Regional Development Agency (ARD) of Thiès within the framework of the construction and operation of the Malicounda thermal power station.

**Date:** Tuesday July 11, 2017

**Start time:** 12h00mn

**Duration:** 01 hour

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Present

-ARD of Thiès

Mr. Abdou Karim Sow: Head of ARD

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the project**

- In Malicounda there is a strong social tension linked to the land heritage;
- The station will be in a tourist area (Ngnaning, Pointe-Sarene, Ngekhokh) and is close to Saly, the management of the waste generated therefore remains a matter of concern;
- If the local authority has a clear waste management policy, it could submit it to SENELEC in order to orient its CSR policy towards improving the living conditions of the populations.

**Expectations and recommendations of the ARD of Thiès**

- Relocate the identified subdivisions to another compensation site for the former owners;
- Take into consideration the Malicounda solar power plant which donated a share of its capital to the municipality.

Public consultation with the deputy to the governor of Thiès in the context of the construction and operation of the Malicounda thermal power plant.

**Date:** Tuesday July 11, 2017      **Start time:** 12h19mn      **Duration:** 01 hour

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Present

-Thiès governance

Mr. Mbassa Sène

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda :**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Expectations and recommendations of the governor of Thiès**

- Take the appropriate measures to protect populations because transporting heavy fuel oil from Dakar to Malicounda can be dangerous;
- Protect populations from any risk of fire or explosion;
- Involve the mayor of Malicounda and the Departmental Council in the capital.

Public consultation with the Regional Planning Department of Thiès within the framework of the construction and operation of the Malicounda thermal power plant.

**Date:** Tuesday, July 11, 2017      **Start time:** 3:00 p.m.      **Duration:** 01 hour

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Present

-Regional Planning Service of Thiès

Mr. Lamine CISSOKHO: head of service

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;

2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment

### **Opinion and perception on the project**

- This project allows the diversification of the production areas which were concentrated in Tivaouane;
- It also makes possible to increase the energy potential which leads to the development of economic activities;
- It is an important step towards energy self-sufficiency;
- It raises fears related to the negative impact on the agricultural areas which will decrease and to air pollution

### **Expectations and recommendations of the Regional Planning Department of Thiès**

- Participate in the local development effort;
- Promote local employment.

Public consultation with the Regional Division of the Environment and Listed Establishments (DREEC) within the framework of the construction and operation of the Malicounda thermal power plant

**Date:** Tuesday, July 11, 2017

**Start time:** 5:00 p.m.

**Duration:** 30 minutes

#### **Present**

-DREEC

Mr. Moussa GUEYE: head of service

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

### **Agenda:**

1. 1. Opening ceremony and presentation of the representatives of the EES firm;
2. 2. Presentation of the project to build and operate the power station;
3. 3. Exchanges and recommendations;
4. 4. Adjournment.

### **Expectations and recommendations of Thiès DREEC**

- Secure the land belonging to SENELEC as well as the High Voltage (HT) rights-of-way;



- Check the subdivisions and consider them as fields during negotiations for the payment of expenses
- Suggest the best technologies to limit pollution;
- Make an internal follow-up of the environmental components likely to be affected by the project and inform the administration periodically about the result of these follow-ups;
- Determine the reference state of the site;
- Sort the waste and put it in the correct disposal channels;
- Ensure good management of wastewater and whether there is the possibility of recycling it, recycling it and reusing it internally;
- Get closer to the Hydraulics Department and the DGPRE.

Public consultation with the Regional Department of Mines and Geology in the context of the construction and operation of the Malicounda thermal power plant.

**Date:** Wednesday July 12, 2017

**Start time:** 09h18mn **Duration:** 01 hour

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Present

-Regional Mining and Geology Service

Miss Ndèye COULIBALY

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception of the Project**

- The map presented in the information document is taken from Google, which does not give a precision on the distance from the dwellings;
- The information document does not highlight all the elements of the process; it should have provided an understanding of the salient elements of the station;
- Noted that there are dwellings and a road next to the site.

**Expectations and recommendations of the Regional Service of Mines and Geology**

- Control pollution and accidents;
- Develop a CSR policy;
- Present the ground and site plans;
- Contact the mining cadaster in Dakar for the situation of authorized quarries in use in the locality, these quarries must be 500 m from the dwellings;
- Carry out a hydrogeological study of the borehole.

Public consultation with the deputy to the prefect of Mbour in the context of the construction and operation of the Malicounda thermal power plant.

**Date:** Wednesday July 12, 2017

**Start time:** 10:19 am

**Duration:** 01 hour

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Present

-Prefecture of Mbour

Mr. Saer NDAO

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the Project**

- The most important at the departmental level is the involvement of all the technical services of the State to meet the expectations of the project;
- This project is part of the emergency recovery plan for the electricity sector;
- Each SENELEC project is stored in a program, such as the PASE (Energy Sector Support Plan).

**Mbour prefecture's expectations and recommendations**

- Get closer to the sub-prefect to facilitate meeting with the populations;
- Launch a good communication plan;
- Inform the sub-prefect on the occupation of the site;
- Solve the problem of evacuation of discharges;
- Solve the problem of land use

Public consultation with the Electricity Sector Regulatory Commission (CRSE)  
in the context of the construction and operation of the Malicounda power plant.

**Date:** Wednesday July 12, 2017

**Start time:** 11h15mn

**Duration:** 30 minutes

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Present

-CRSE

Ms. Paule Marie LAKH

-EES cabinet

Malick DIALLO

Mintou NDIAYE

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**Agenda :**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the Project**

- The granting of the license can be done following the completion of impact studies;
- The CRSE is an independent administrative authority which takes decisions which can only be challenged at the Supreme Court;
- The Secretary General of CRSE encourages this kind of project which contributes to the country's electricity demand.

**CRSE expectations and recommendations**

- Provide a good CSR policy such as compensation, compensation, etc. ;
- Settle the land problem recurrent in this area.

Public consultation with the Departmental Service of Town Planning of Mbour  
within the framework of the project of construction and exploitation of the  
thermal power plant of Malicounda

**Date:** Wednesday July 12, 2017

**Start time:** 11h18mn **Duration:** 01 hour

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Present

-Departmental Department of Town

Planning of Mbour

Mr. Abdoulaye DIOUF: head of service

-EES cabinet

Yacine DIOP

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### **Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

### **Opinion and perception on the project**

- The presence of subdivision inside the site is the first concern, which is understandable because after two (02) years, if a site is not operated after a deliberation, the land code allows its decommissioning and its reassignment to a third party;
- But given the importance of the project, the plots could be relocated to another site;
- SENELEC has an extract from the plan which is a cadastral document made by the Cadastre office. It must initiate a procedure for securing the land.

### **Expectations and recommendations of the Departmental Service of Town**

#### **Planning**

- Find resettlement sites for landowners who are in their rights with the mayor's agreement;  
Take into consideration the negative externalities of the project and propose adequate mitigation measures;
- Securing the land by approaching the municipality and the STE;
- Introduce the building authorization file;
- Inquire about the situation of the subdivisions;
- Obtain a lease title from the Domains office;
- Make the medical examination before hiring and every 06 months;
- Raise awareness of the risks associated with the presence of electrical devices;
- Get closer to the fire brigade.

Public consultation with the town mayor of Malicounda within the framework of the project of construction and exploitation of the thermal power station of Malicounda

**Date:** Wednesday July 12, 2017

**Start time:** 13h18mn **Duration:** 01 hour

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Present

-Malicounda town hall

Mr. Bakary SENE: first deputy mayor of Malicounda

-EES cabinet

Yacine DIOP

Fatima Samba SARR

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the project**

- The town hall holds 5% of shares in the solar power station located in the town;
- Companies do not respect commitments and promises and especially in monitoring negative impacts;
- The municipality has 22 villages, some of which are not electrified;
- The coverage rate of access to water remains still low in 03 villages of the municipalities: Sass, Ngoogome and Takhum;
- The plots located on the site have no administrative acts.

**Expectations and recommendations of the town hall of Malicounda**

- Set up a system for monitoring parameters for the health of populations;
- Make a reference situation on existing diseases in the locality with the district doctor;
- Reinforce the system of access of populations to basic social needs (water, electricity, education etc.);
- Provide shares in the company for the municipality;
- Make the land parcel identification on the site;
- Consult the hydraulics department for drilling.

Public consultation with the Departmental Council of Mbour within the framework of the construction and operation of the Malicounda thermal power plant.

**Date:** Thursday, July 13, 2017

**Start time:** 10:18 am **Duration:** 01 hour

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Present

-Departmental Council of Mbour

Ms. SAMB: general secretary

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the project**

- The project is a good initiative;
- The Department Development Plan (PDD) is being developed;
- The safety of populations with regard to the location of the site is a major concern.

**Expectations and recommendations of the Mbour Departmental Council**

- Promote the employment of local unskilled labor;
- Carry out the policy of positive discrimination for positions requiring a qualification, that is to say with an equal qualification, and give priority to nationals of the locality.

Public consultation with the Regional Labor and Social Security Inspectorate (IRTSS) of Thiès in the context of the construction and operation of the Malicounda thermal power plant.

**Date:** Thursday, July 13, 2017 **Start time:** 3.30 p.m.

**Duration:** 01 hour

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Present :

*-IRTSS of Thiès*

**Mr. Amadou NIANG**

*- EES cabinet*

**Fatima Samba SARR**

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the project**

- The establishment opening declaration is compulsory and must be accompanied by at least one (01) employment contract;
- This declaration of establishment will make possible to have recourse to a Health Insurance Institution (IPM) for non-professional illnesses;
- The Declaration of Worker Movements (DMT) makes it possible to join the Social Security Fund and IPRES. It should be noted that it is the fund which takes care of accidents at work and occupational diseases;
- If the company has more than 300 employees, it is required to create its own IPM;
- If the company has less than 300 employees, it can join an IPM among a multitude of structures;
- The employer is obliged to pay overtime hours beyond 40 hours per week with tariffs, depending on the day or night, increased by 100% for rest days and public holidays;
- The employer has the obligation to organize the employee representative elections starting from eleven (11) workers;
- The CHSST is compulsory starting from 50 employees. This committee consists of 06 people including the company doctor. However, the inspector can estimate the need to install a CHSST without the workforce reaching fifty (50) workers depending on the general working conditions;
- The employment contracts must be written when it is a fixed-term contract or temporary contracts (trainees, temporary, seasonal ...);

- The pay slip is compulsory and must mention all wage headings (basic salary, overtime wages, tax and social deductions). Note that payment of wages is compulsory from the day 08 of every month.

### **Expectations and recommendations of Thiès IRTSS**

- Set up an employer register made up of three (03) booklets. The third is reserved for the IRTSS;
- Focus on OSH and take all the necessary precautions to control the risks to which employees are exposed;
- Train workers for the prevention of accidents at work and take into account the decrees of 2006 relating to the HSST committee which fixes the threshold for the establishment of this committee when the structure has at least fifty (50) workers;
- Elect a staff representative whatever the phase of the project when the workforce is eleven (11) employees;
- Establish a work medicine and reconcile medical visits which can be done every six (06) months;
- Establish work contracts which must be written when it is a fixed-term contract or temporary contracts (trainees, temporary workers, seasonal workers ...);
- Set work schedules and provide day workers with pay slips.

Public consultation with the Directorate of Electricity in connection with the construction and operation of the Malicounda power plant.

**Date:** Friday July 14, 2017

**Start time:** 08h10mn

**Duration:** 50 minutes

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**Present :**

*-Direction of Electricity*

*Ibrahima NIANE*

*-EES cabinet*

*Malick DIALLO*

*Mintou NDIAYE*

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### **Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

### **Opinion and perception on the project**

- The project is relevant because it will build capacity to meet needs and it is part of the energy mix program;



- The use of gas is expected by 2025 after the start of exploitation of the gas discovered in Senegal;
- The project site is justified by the fact that Dakar is saturated and especially by the proximity to the transformer station;
- SENELEC does not have a production deficit for the moment but it is necessary to anticipate future needs;
- According to SENELEC criterion n-2, if two (02) power plants fail, the rest should meet the needs of the population;
- Rural electrification of Mbour area is provided by a Tunisian electricity distribution company (STL). However, SENELEC has already served certain areas of this region at lower prices. Though, the state will ensure that tariffs are the same through a compensation system.

### **Expectations and recommendations of the Electricity Department**

- 
- Ensure the autonomy of the plant (10 days) thanks to the storage of heavy fuel oil;
- Employ qualified workers;
- Think on a good CSR policy;
- Study the compass rose;
- Provide very high chimneys.

Public consultation with the African Refining Company (SAR) in connection with the construction and operation of the Malicounda power plant

**Date:** Friday July 14, 2017

**Start time:** 10:20 am

**Duration:** 01 hour

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#### **Present**

-SAR

Maxime NDIOLÉNE

Papa Talla DIANÉ

Moussa NDIAYE

Fode Kaba NDIAYE

Oumar DIAKHATE

-EES cabinet

Malick DIALLO

Mintou NDIAYE

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### **Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

### **Opinion and perception on the project**

- The convoy of a dozen trucks carrying heavy fuel oil will be very dangerous and risky;
- Heavy fuel oil is a substance that freezes at room temperature, its storage requires special temperature conditions;
- The flash point of heavy fuel oil which corresponds to the temperature at which the fuel emits enough vapors to ignite in the presence of a heat source is around 70 °C to 90 °C;
- In the event of an explosion, this could have impacts on neighboring villages or on neighboring roads;
- Explosions, fires, etc. are not the only possible accidents, there is also a probability of implosion of the storage tanks. This is the only accident encountered at the SAR level. Implosion occurs when the pressure in the tank is lower than the external pressure and in the case of storage tanks, this phenomenon occurs due to blockage of the supply conduits or vents;
- In Senegal, databases on accidentology are almost non-existent;
- The creation of instructions must be carried out by an expert who has obtained his approval by Decree.

### **RAD expectations and recommendations**

- Promote storage tanks for truck convoys;
- Transport the fuel with trucks equipped with adequate storage systems;
- Provide a safe distance between storage tanks, facilities and roads;
- Heat the safety bins either with steam or with an electric heating system;
- Plan a good CSR policy by creating infirmaries, schools, etc.;
- Use filters to reduce gas emissions;
- Carry out different scenarios related to the explosions to predict the number and capacity of the tanks;
- Store heavy fuel oil in tanks with a fixed roof fitted with a vent;
- Employ qualified people;
- Train employees on an ongoing basis;
- Inquire about all the information necessary because while the gas appear less polluting, its use is more dangerous;
- Create a hygiene committee;
- Provide signaling and fire alarms in control panel.

Public consultation with the Regional Agency for Statistics and Demography of Thiès within the framework of the construction and operation project of the Malicounda power station.

**Date :** Friday, July 14, 2017      **Start time :** 5.30 p.m.      **Duration :** 01 hour

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Present

-Regional Statistics Agency

Mrs. Oumy LAYE: Head of the agency

-EES cabinet

Yacine DIOP

Fatima Samba SARR

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the project**

- Electrical installations often do not respect the security perimeter;
- It is important to identify the potential impacts of the plant on its reception environment.

**Expectations and recommendations of Thiès Regional Statistics and Demography**

**Agency**

- Take into consideration the security perimeter when designing the plant;
- Materialize this security perimeter by a markup;
- Make the reference state on the health of local populations;
- See the possibilities of relocating the power plant if the impacts are deemed to be very significant.

Public consultation with the sub-prefect of Sindia in connection with the construction and operation of Malicounda power plant.

**Date:** Friday July 14, 2017      **Start time:** 5:45 pm      **Duration:** 01 hour

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### Present

-Sindia prefecture

Mr. Mountaga SALL: sub-prefect

-EES cabinet

Yacine DIOP

Ndèye Fatou Mbow DIOUF

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### **Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

### **Opinion and perception on the Project**

- It is noteworthy that there were the presence of plots and traditional fields on the site to host the thermal power plant project, but SENELEC had neither carried out the survey, the census or the payment of expenses;
- The owners of these plots have established themselves irregularly without authorization or deliberations;
- In Malicounda area, there have often been land disputes because the traditional owners of fields do not have administrative instruments.
- This is why it is imperative to carry out a land plot identification in order to make an identification for the project area;
- The deliberation of SENELEC dates from 2012 and two (02) years after a deliberation, if the land is not valued or secured, a lack of interest and assignment can occur without the owner's notification;
- This is why it is very likely that the people present in the SENELEC area have a deliberation or are traditional owners of fields;
- Even if this power plant is an obsolete and expensive technology, it is to be welcomed if it increases electricity production performance by reducing production costs and negative externalities in relation to the environment.

### **Expectations and recommendations of Sindia sub-prefect**

- Enter the prefecture of Thiès which will in turn enter the Departmental Commission for the Assessment and Payment of Expenses for the census of people affected by the project;
- Get closer to the president of the national commission of Malicounda;
- Check the property titles of the people present on the site and whether they were allocated before or after the deliberation of SENELEC;
- Proceed to the payment of expenses for the people affected by the project and who are in their rights or propose an adequate compensation measure;
- Secure the land with markup;

- Take adequate security measures in the two phases of the project to ensure the safety of populations because the power plant will be located in an urban environment.

Public consultation with the Regional Division of Hydraulics of Thiès within the framework of the project of construction and exploitation of the thermal power station of Malicounda.

**Date:** Wednesday July 19, 2017 **Start time:** 10:00 am **Duration:** 01 hour

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Present

- Regional Division of Hydraulics of Thiès  
Mr. Baba DIENG  
-EES cabinet  
Yacine DIOP

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the Project**

- There are two (02) aquifers in the area: the Paleocene, which has a depth between 60 and 80 m and the Maestrichtien, which has a depth which varies between 200 to 250 m; eg: the Malicounda borehole is 222.45 m deep and the Fandane borehole 222.70 m;
- In 2014 there were 38 standpipes and 18 community connections

**Other Expectations and recommendations of the Regional Hydraulic Division of Thiès**

Conduct a hydrogeological study to determine the quantity and depth of the aquifer captured.

Public consultation with the Air Quality Management Center (CGQA) of the Directorate of the Environment and Listed Establishments (DEEC) within the framework of the construction and operation of Malicounda thermal power plant.

**Date:** Wednesday, July 26, 2017 **Start time:** 3:00 p.m. **Duration:** 30 minutes

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Present

-CGQA

Aminata Mbow DIOKHANE

-EES cabinet

Seynabou Diatta NDIAYE

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Summary presentation of the construction and operation project of the thermal power station in Malicounda;
2. Discussion and opinions exchange, fears and concerns of the CGQA;
3. Recommendations proposed by the CGQA;
4. Adjournment.

**Opinion and perception on the Project**

- At the site of the future Malicounda thermal power plant, there is already the presence of a cell production plant. It would be interesting to know the emissions from the existing cell plant in order to assess the cumulative effects with the thermal power plant;
- During fuel storage, there will be the emanation of Volatile Organic Compounds (VOCs) which can pollute the environment during their evaporation;
- The air quality measurements in the initial state will make it possible to see the incidents of the project on air quality during the construction phase and during the operation of the plant.

**Expectations and recommendations of the CGQA**

- Ensure that the smoke emissions comply with the pollutant emission regulations (PM5; PM 2, 5; SO2);
- Carry out air quality measurements before the construction phase and the operation phase in order to be able to determine the baseline situation;
- Carry out periodic emission measurements and declare them before the Ministry of the Environment;
- Continue monitoring to check the limits in relation to the regulations.

Public consultation with the Directorate of Water Resources Management and Planning (DGPRE) as part of the construction and operation project for Malicounda thermal power plant.

**Date:** Monday July 31, 2017

**Start time:** 09h25mn

**Duration:** 01 hour

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Present

-DGPRE

Khoudia F. MBENGUE

Mouhamadou D. FALL

-EES cabinet

Seynabou Diatta NDIAYE

Ndèye Fatou Mbow DIOUF

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**Opinion and perception on the Project**

- A study on the technological variants concerning the use of water resources must be carried out because it will provide information on the best device to set up;
- The source of water supply for the needs of the project must be specified;
- The source selected must guarantee both the viability of the project over time and the sustainability of the resource;
- If the water used comes from ASUFORs, the project must give guarantees that the drilling can support both the needs of the plant and those of the community;
- Malicounda will experience an extension of the area which will generate new urban centers, this is why new works are being carried out in the area by SONES to meet these new needs;
- Malicounda area has the Palaeocene, which is salty, and the Maestrichtian, which has fresh water. However, there are ground-waters captured by the wells but which dry up at times during the year;
- During the construction phase of the plant, there is not really a big issue but during the operation of the plant, it will need a significant amount of water.

**Expectations and recommendations of the DGPRE**

- Quantify the daily water needs of the plant and see how many supplies will be necessary to meet these needs;
- Declare in the analysis of variants the possibilities of using seawater for the cooling needs of the plant;
- See the possibilities of using the flood water after recycling it in order to improve the positive impacts on the environment;
- Treat wastewater before discharge;
- Collect hydrogeological information from the area;
- Carry out feasibility studies.

Public consultation with the Pollution and Nuisance Control Division (DCPN) of the DEEC within the framework of the construction and operation of the Malicounda thermal power plant.

**Date:** Monday, July 31, 2017    **Start time:** 12:30 p.m.    **Duration:** 30 minutes

Present

-DCPN

Coumba Aïcha Niang DIEYE

-EES cabinet

Seynabou Diatta NDIAYE

Ndèye Fatou Mbow DIOUF

**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

**DCPN expectations and recommendations**

- Secure the storage of fuels (hydrocarbons) and oils by ensuring the proper tightness of their retention and storage tanks;
- Ensure compliance with standard NS 05-061 before any discharge of wastewater;
- Ensure proper management of sludge from wastewater treatment;



- Provide a device for purifying atmospheric discharges;
- Establish a waste management system;
- Ensure that the diesel storage is far from the ERP;
- Respect storage standards, ensure the compatibility of chemicals during their storage, ensure that the personnel in charge of these products is qualified and trained in its use and handling;
- Hand over the used batteries (which will mainly be present in the control room) to approved companies for their recovery;
- Set up a collection system for used oils to deliver them to approved companies;
- Install soundproof generator sets;
- Provide and ensure the installation of adequate PPE according to the workstation;
- Display the safety instructions.

Public consultation with the Environmental Impact Assessment Division (DEIE) of the DEEC within the framework of the construction and operation project of Malicounda thermal power plant.

**Date:** Monday, July 31, 2017    **Start time:** 1:00 p.m.    **Duration:** 30 minutes

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Present

-DEIE

Cheikhou DANSOKHO

-EES cabinet

Ndèye Fatou Mbow DIOUF

Seynabou Diatta NDIAYE

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**Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;
3. Exchanges and recommendations;
4. Adjournment.

### **DEIE's expectations and recommendations.**

- Model the atmospheric dispersions of emissions;
- Take the appropriate measures to avoid fires in the oil storage tanks;
- Define the baseline situation for the water resource in order to know the impact of the cooling of the station on the resource;
- Have the required authorizations from the hydraulic services;
- Offer a good management of water resources by installing a device that allows water reuse;
- Have the necessary permits for construction from the town planning department;
- Highlight all the impacts related to civil engineering works (for the installation of new pylons if necessary);
- Secure the site's land hold;
- Compensate the PAPs and set up a good communication and awareness plan for the MV and HV lines;
- Suggest a plant layout plan for the plant block;
- Stress particularly on the study of dangers and propose a modeling on the distances of effects.

Public consultations with the local population of Malicounda in connection with the construction and operation of Malicounda thermal power plant.

**Date:** Thursday August 10, 2017    **Start time:** 10:30 am    **Duration:** 06 hours 30 minutes

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#### **Present**

##### **Population of the villages of:**

- Sericounda Malicounda
- Malicounda Bambara
- Malicounda Wolof

**-EES cabinet**

**Yacine DIOP**

**Fatima Samba SARR**

**Ndèye Fatou Mbow DIOUF**

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### **Agenda:**

1. Opening ceremony and presentation of the representatives of the EES firm;
2. Presentation of the project to build and operate the power station;

3. Exchanges and recommendations;
4. Adjournment.

The results of the exchanges carried out with the populations of the three (03) villages of the municipality of Malicounda are recorded in the following tables:

Table 1: Public consultation with the residents of the village of Malicounda Sérère

Village	Opinions, fears and concerns vis à vis the project	Recommendations suggested by the population
<p>The village of Malicounda Sérère is composed of four (04) districts (Malicounda Nguerigne, Malicounda Sass, Malicounda Ngongom; Malicounda Ngoukhoudj and Malicounda Ndiadiam)</p>	<ul style="list-style-type: none"> <li>• The presentation of the project to the populations is a great initiative to welcome;</li> <li>• Promises made by promoters are rarely kept, especially with regard to the employability of young people;</li> <li>• The area of the project site covers an area of 13 ha in the villages of Keur Meissa Faye in Malicounda Ouolof, Malicounda Nguerigne and affects a field in Malicounda Bambara;</li> <li>• The owners of the land were not informed of SENELEC's deliberation which dates from 2012;</li> <li>• There has been no compensation or census of PAPs since then;</li> <li>• The populations must be informed of the constraints linked to the project in relation to the environment, breeding and agriculture;</li> </ul>	<ul style="list-style-type: none"> <li>• Recruit local labors with equal qualification; in the construction phase and in the operation phase, even if it requires training local populations who are students;</li> <li>• Invite young graduates from Malicounda to be employed in the plant;</li> <li>• Recruit in the operational phase on the basis of aptitude test results, tests which will be followed by qualifying training;</li> <li>• Propose a recruitment quota for young people in the municipality for qualified and unqualified jobs;</li> <li>• Train young people and women for the jobs to be filled;</li> <li>• Propose adequate security measures in order to preserve the environment, people close to the power plant, livestock and agriculture;</li> <li>• Benefit from the advantages of the plant in favor of the municipality by paying taxes;</li> <li>• Improve the electrification to the municipality. Facilitate access to electricity by reducing electricity costs; or by offering the current;</li> </ul>

Village	Opinions, fears and concerns vis à vis the project	Recommendations suggested by the population
	<ul style="list-style-type: none"> <li>• Malicounda is a rapidly expanding commune, it is ready to receive all projects by making land available to promoters, but on condition that the young people of Malicounda are recruited for skilled and unskilled jobs;</li> <li>• This project is welcomed, the deliberation of SENELEC dates from 2012 and the fragmentation was carried out in 2016. The owners bought these lands;</li> <li>• The municipality of Malicounda has enough land assets to accommodate new projects.</li> </ul>	<ul style="list-style-type: none"> <li>• Facilitate access to water (more precisely the populations of Malicounda Ngongom and Malicounda Sass) by reducing the price of electricity for ASUFOR, which in turn will affect the price of m3 of water;</li> <li>• Respect the commitments and promises given to the populations and not follow the example of promoters who set up with their project and who do not keep their commitments;</li> <li>• Offer a market garden perimeter and install new drilling in the fifteen (15) ha planned for the power station in order to support the populations;</li> <li>• Create a perimeter of negotiations between the town hall and the populations for the compensation of the PAPs;</li> <li>• Provide clear contracts and insurance for future employees of the station during the construction phase and the operation phase;</li> <li>• Leave to the town hall to negotiate compensation for the PAPs;</li> <li>• Inform about the potential impact of power plants on the health of residents and workers;</li> <li>• Compensate the PAPs to avoid any social tension.</li> </ul>

Table 2: Public consultation with the residents of the village of Malicounda Bambara

Village	Opinions, fears and concerns vis à vis the project	Recommendations suggested by the population
<p>Village of Malicounda Bambara which is composed of 10 districts</p>	<ul style="list-style-type: none"> <li>• This project is a source of pride for the municipality of Malicounda;</li> <li>• The first obvious fear is the air pollution that will emanate from the power station. This smoke will accentuate global warming, especially in Malicounda where it is very hot during the dry season;</li> <li>• The initiative to inform the populations about this project is really to be welcomed;</li> <li>• This plant will be the third to be established in the commune and the promises given by the promoters are rarely kept;</li> <li>• The majority of projects occurring in Malicounda are electrical projects which represent a danger for residents and surrounding populations.</li> </ul>	<ul style="list-style-type: none"> <li>• Recruit the local population with equal qualification;</li> <li>• Take the necessary mitigation measures to avoid any danger of any impact on the population and the environment;</li> <li>• Train the young people of the locality for their qualification before their recruitment;</li> <li>• Reduce electricity costs and cuts of electricity;</li> <li>• Suggest technical means to recover smoke from power plants;</li> <li>• Move the plant to another location where people will not be exposed to smoke.</li> </ul>

Table 3: Public consultation with the residents of the village of Malicounda Wolof


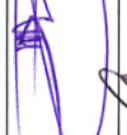

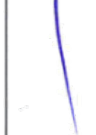


Village	Opinions, fears and concerns vis à vis the project	Recommendations suggested by the population
<p>The village of Malicounda Wolof is composed of 04 districts</p>	<ul style="list-style-type: none"> <li>• The first observation is that the SENELEC site was deliberated without a plan in 2012, thereafter there were allotments of plots within this same site;</li> <li>• The site in question belonged to certain residents of Malicounda who practice agriculture there, the deliberation of their land was made without their knowledge and without their approval;</li> <li>• As a result, there was no payment of expenses;</li> <li>• Given the influx of numerous power stations in Malicounda area, the village of Malicounda Wolof, more precisely the Keur Meissa Faye district is in danger of disappearing;</li> <li>• The underground cables present in Keur Meissa district which connect the power plants already on site to the transformer station raise concerns for the populations of Keur Meissa Faye, in addition to the establishment of this new power plant;</li> </ul>	<ul style="list-style-type: none"> <li>• Pay the PAP expenses;</li> <li>• Do not apply the state scale when paying PAP expenses;</li> <li>• Based on the estimation of compensation on what a year of farming brings in and report it over the 25 years (lifetime of the power plant);</li> <li>• Compensate the PAPs for the two (02) ha already used by SENELEC for the establishment of the transformer station;</li> <li>• Respect the distance of 500 which must separate the power plant from the first dwellings;</li> <li>• Sign an agreement with the town hall to create a local recruitment committee;</li> <li>• Sign clear agreements with the legally based town hall for the application of the CSR policy;</li> <li>• Provide enough electricity so that the Municipality of Malicounda will no longer experience load shedding;</li> <li>• Invest within the framework of the CSR policy, in social projects, by setting up a health center, with qualified doctors and a good technical platform;</li> <li>• Build schools and high schools to strengthen education;</li> <li>• Support the women's group with land donations to support small businesses or set up fruit and vegetable processing units;</li> <li>• Reinforce the existing drilling by installing a new drilling;</li> </ul>

Village	Opinions, fears and concerns vis à vis the project	Recommendations suggested by the population
	<ul style="list-style-type: none"> <li>• The upsurge in power stations poses a problem for the populations of Malicounda, because during the wintering there are vibrations that come out of the ground, and sparks in the overhead lines;</li> <li>• Beyond the payment of expenses, the promoter must accompany the populations in the realization of community projects, and to follow this well the Town Hall must have the legal authority over him.</li> </ul>	<ul style="list-style-type: none"> <li>• Participate with the town hall in the maintenance of roads so that they meet standards;</li> <li>• Support mosques and Koranic schools “Daarras” by donating equipment (radios, carpets, etc.) or by renovating;</li> <li>• Make a film projection to explain how the power plant works in order to raise awareness of the dangers linked to its operation;</li> <li>• Propose adequate mitigation measures in order to limit the potential impacts of the plant on health;</li> <li>• Allow the populations of Malicounda, especially the PAPS, to benefit from a reduction in the cost of electricity;</li> <li>• Take into consideration the presence of other districts when establishing the bypass road;</li> <li>• Keep the promises made to the people;</li> <li>• Employ local women and youth;</li> <li>• Provide a generator for the operation of Malicounda Wolof drilling;</li> <li>• Compare old SENELEC plans with new plan</li> </ul>

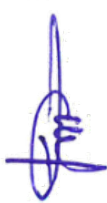





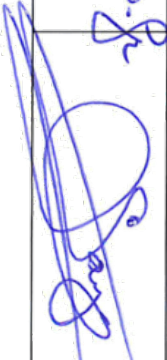
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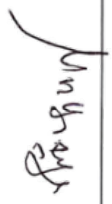


Date	Structure	Nom et Prénoms	Fonction	Contact + Mail	Embarquement
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Date	Structure	Nom et Prénoms	Fonction	Contact + Mail	Embarquement
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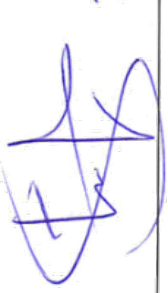
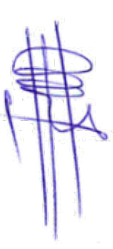
DATE	Prénoms	Nom	Service	Mail / Téléphone	Cachet + Emarquage
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### FEUILLE D'EMARGEMENT

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Date	Structure	Nom et Prénoms	Fonction	Contact + Mail	Emargement
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LETRES D'INFORMATION PRELIMINAIRE

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	Amadou	Gon	AGÉKOUFE	33 869 57 59	
	Banque Mondiale	Comba	Banque Mondiale	33 859 11 00	





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DATE	Prénoms	Nom	Service	Mail / Téléphone	Cachet + Emargement
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05/07/2017	Amy	Dieng	DETE	781614445	 DIRECTION DE L'ENVIRONNEMENT ET DES ETABLISSEMENTS CLASSES Division de l'Environnement et du Contrôle
05/07/2017			DIC	338223848	 Republique du Sénégal DIRECTION DE L'ENVIRONNEMENT ET DES ETABLISSEMENTS CLASSES Division de l'Environnement et du Contrôle



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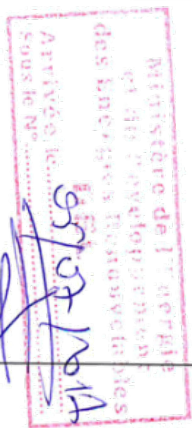


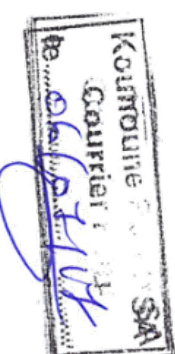
DATE	Prénoms	Nom	Service	Mail / Téléphone	Cachet + Emargement
05/07/14	Hadjouatou A	WONE	APC	33 829 39 00 dpceen@fastmail.com	 Wouly
05/07/14	Prime Odéye A Sène	SENE	DRI/min	33/822-04-20	
05/07/17	Mare	DIATTA	CRSE	33 849 0459	
05/07/17	Prime Odéye A		DEPRE	338222454	





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DATE	Prénoms	Nom	Service	Mail / Téléphone	Cachet + Emargement
		M. Samba	DEL	33 989 27 35	
	Lacky	SENE	SEHAC SA	33 839 73 09	
	Isamo	Baye	TOBÈNE POWER SA	33 820 92 12	
	Isamo	Baye	HOUSSEBOUC	33 828 12	



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06/07/2017	Diouane	Cell.	Se Louisa.	01.338398499-	
06/07/2017	Idriss Kine	CANADA	OPERATIONS	33 83 6 36 81	

## LETRES D'INFORMATIONS PRELIMINAIRES

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### FEUILLE D'EMARGEMENT

DATE	Prénoms	Nom	VILLAGE	Mail / Téléphone	Cachet + Emargement
27 07 2017	Sadio	TRAORE	Malicounda Bambana	77.643 55 36	
27 07 2017	Maguette	Dieng	Malicounda Sereze	77 8234668	
27 07 2017	El Hadji	KHOUNA	Malicounda Bambana	77.305.26-78 77.632.5770	






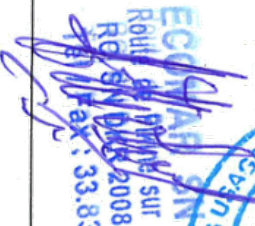



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LETRES D'INFORMATIONS PRELIMINAIRES

FEUILLE D'EMARGEMENT

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27 07 2017	Nabou	Diehahé Feye	Malicounda Oudof	77 683 72 58 77 662 76 83	
27 07 2017	MRacke	Babou	Malicounda Oudof Fayaye	77 652.07.17	 
04/ 08/ 17	Econom			776117619 772518125	 

## Gallery on public consultations with the populations of Malicounda



**Photo 1: Malicounda Sérère**



**Photos 1 and 3 : Malicounda Bambara**



**Photo 4 : Malicounda Wolof**

## **ANNEX 04: FACILITIES PLAN**



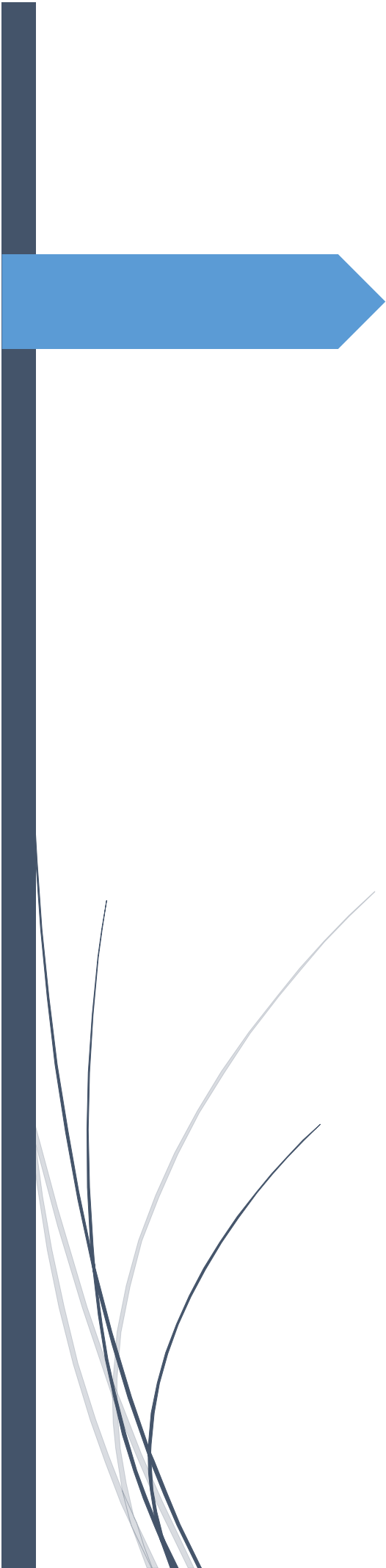




## **ANNEX 5: STUDIES CARRIED OUT**



## **ANNEX 5.1: CHARACTERIZATION OF AIR QUALITY**



# Diesel power station Project in Malicounda

M DIOP  
EES

## Report specification sheet

<b>Title of the project:</b>	Baseline air quality situation at Malicounda / Diesel power station project
<b>Description of the activity:</b>	PM2.5 and PM10, SO2 and NO2 measurement campaigns at the locality of Malicounda
<b>Description of the document:</b>	Ambient air quality baseline report for Malicounda Diesel Generating Station Project
<b>Date of issue:</b>	September 18, 2017
<b>Prepared by :</b>	Serigne Abdoul Lahad YADE, Toxicologist, Specialist in Pollution and Environmental Health, Consultant Center for Air Quality Management, DEEC Dakar
<b>Verified by :</b>	Serigne Abdoul Lahad YADE

### Revision history:

Version	Date	History of Modifications
00	September 18, 2017	Final report



**BTLABS Consulting**



**PRESTIGE**

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## 1. Introduction

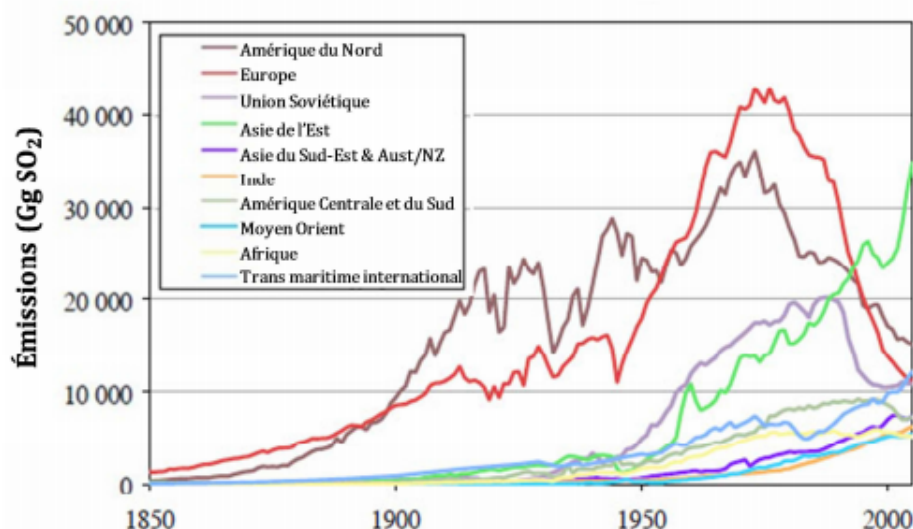
As part of the ESIA for the future Malicounda diesel power station, particle and gaseous pollutant measurement campaigns were carried out by pollution and nuisance expert Serigne YADE. These tests were carried out during the month of September 2017 by the Bio Tox Labs Group at the request of the EES firm. In total, the study will be on a batch of 10 points which constitute sensitive receptors which could be potentially impacting by the future diesel power plant. The impact of such an installation on the environment with regard to atmospheric emissions caused by its operation, requires monitoring of atmospheric discharges in order to prevent possible deterioration of the environment. The presence of agricultural fields in the area is also one of the reasons that oblige us to characterize and study the environment to further assess the impacts of such a project on the environment.

**Important:** The choice of pollutants studied in this study is aligned with the national dynamics in terms of monitoring ambient air quality (DEEC, CGQA). Therefore it was retained:

- **the measurement of PM2.5 and PM10 particles** but especially PM2.5 which have a greater impact on the health of populations (**WHO, 2005**) due to their origins (combustion waste, condensation and nucleation), their particle size and above all of their toxicity towards the cells of the organism. Diesel particles are respirable particles with mutagenic and carcinogenic properties. The toxicity of engine emissions resulting from the combustion of hydrocarbons is way more complex than the products that compose and are multiple. The toxicity of emissions from diesel engines is linked to their particulate phase (free carbon or solid products very rich in carbon, referred to as particles or soot) and to their gaseous phase (consisting mainly of carbon monoxide, oxides of nitrogen, sulfur dioxide and its derivatives, and polycyclic aromatic hydrocarbons). In June 2012, IARC re-examined the exhaust gases from diesel engines and reclassified them as "carcinogenic to humans" (group 1) (**IARC, 2012**) and (**Benbrahim-Tallaa and coll, 2012**). He analyzed data on the mechanisms of carcinogenesis, experimental in animals and epidemiological in humans.
- **The measurement of sulfur dioxide (SO<sub>2</sub>)** due to the very high contents indexed in the fuels marketed in Africa and its impact on the soils by discharge of calcium ions leading to their acidification. In fact, in the absence of non-binding regulations on the sulfur content of fuels in most African countries, SO<sub>2</sub> emissions are known in

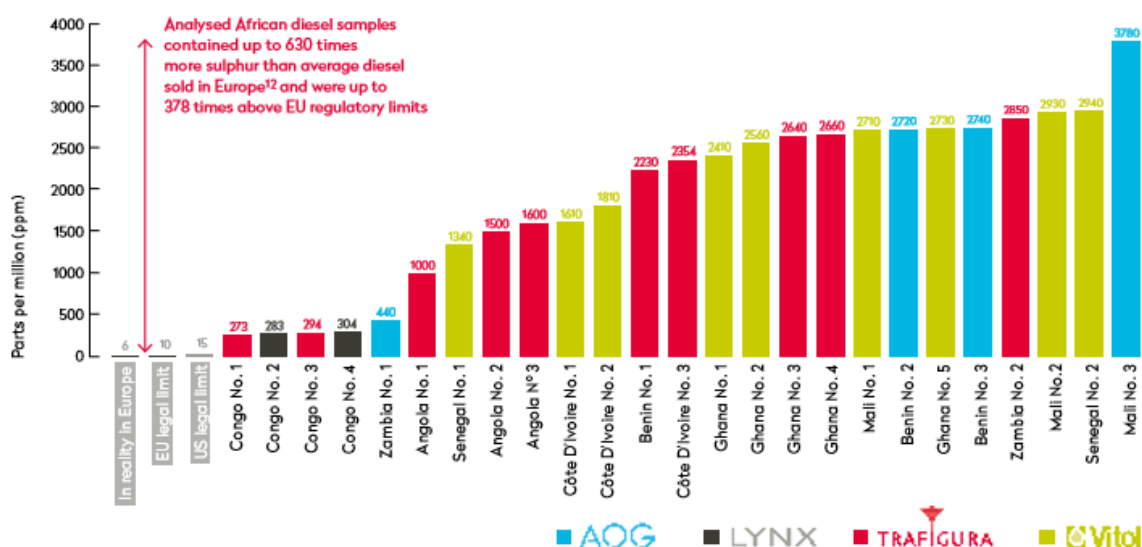
developing

countries.



**FIGURE 1: GLOBAL ATMOSPHERIC SO<sub>2</sub> EMISSIONS (SOURCE: SMITH ET AL. 2011)**

While industrialized countries such as the United States and those of the European Union experienced significant reductions in SO<sub>2</sub> in air in 2005, emerging countries show an opposite trend with increasing SO<sub>2</sub> emissions as illustrated in the figure. 1 above. To this should be added the sulfur contents assumed to be very high in fuels and raised by certain publications



**FIGURE 1: SULFUR CONTENT IN DIESEL IN AFRICA (SOURCE BY PUBLICEYE\_2016)**

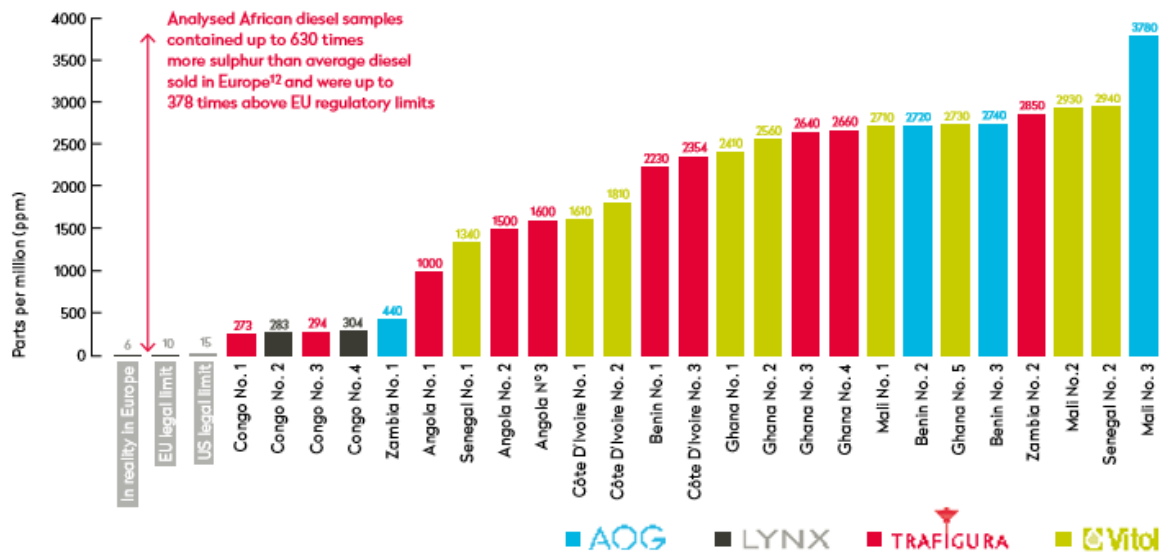


FIGURE 2: SULFUR CONTENT IN FUEL IN AFRICA (SOURCE BY PUBLICEYE\_2016)

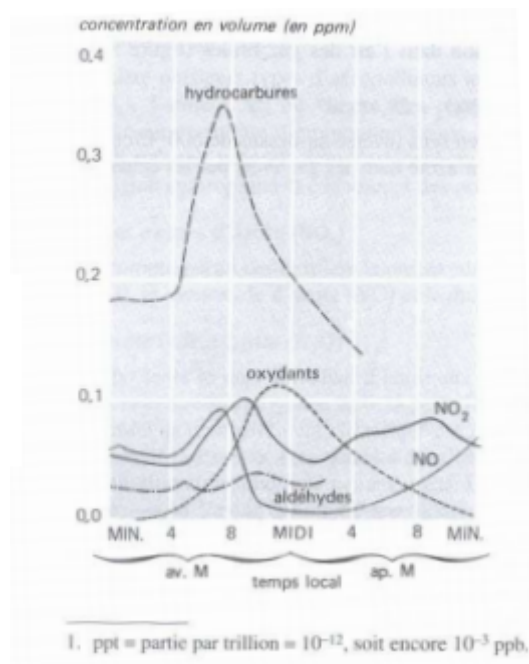
*The measurement of nitrogen dioxide (NO<sub>2</sub>)* for the simple reason that it is a conventional pollutant resulting from the incomplete combustion of fossil and solid energies at high temperature. This gas, also called nitrogen peroxide, constitutes with NO, unlike the previous one, one of the major air pollutants and is of fundamental importance in all atmospheric pollution problems. It is a stable gas, strongly colored in yellow, which greatly reduces atmospheric visibility and in most cases gives a characteristic brownish coloration to the air masses covering urban areas. Furthermore, the particular physical properties of this gas, resulting in a strong absorption of ultraviolet rays, cause its dissociation by the light energy absorbed according to the reaction:  $\text{NO}_2 + h\nu \rightarrow \text{NO} + \text{O}_2 + 72 \text{ kcal (1)}$

It will then generate a so-called photochemical air pollution because it is generated by exposure to NO<sub>2</sub> radiation and these decomposition products with other contents in the polluted air: sulfur dioxide, oxygen, hydrocarbons. Among the various substances formed, some such as peroxyacynitrates (PAN), are phytotoxic and very irritating for the conjunctiva. The presence of nitrogen dioxide in the atmosphere results in part from a side reaction that occurs spontaneously with nitrogen monoxide. It is found, in fact, that automobile releases gases and in general all those produced by combustion at high temperature contain a lot of monoxide than nitrogen peroxide. The latter is formed during the reaction which takes place during the air dilution phase of the burnt gases. This has the equation:  $2 \text{ NO} + \text{O}_2 \rightarrow 2 \text{ NO}_2 + 28.4 \text{ kcal (2)}$

This reaction tends to take place in the opposite direction above 600 ° C which explains the preponderance of nitrogen monoxide in the gases emitted by the exhausts. In highly polluted urban areas, the concentration of nitrogen peroxide can exceed 0.1 ppm or (191 µg / m<sup>3</sup>) as in the following figure.

FIGURE 3: VARIATION OF THE CONCENTRATION IN THE ATMOSPHERE IN VARIOUS POLLUTANTS DURING A DAY IN THE LOW PARTS OF LOS ANGELES





The mandate granted by the EES cabinet to the expert Serigne YADE in collaboration with the Prestige cabinet, allowed the sampling of PM<sub>2.5</sub>, PM<sub>10</sub> dust particles but also of gaseous pollutants such as SO<sub>2</sub> and NO<sub>2</sub> in the selected source points. The acquisition of micro-meteorological data was also carried out at the various selected sampling points.

The chemical composition of air depends on several factors and results from a very complex mixture of hundreds of pollutants that are difficult to quantify. Naturally, certain pollutants exist in the air at variable concentrations and which sometimes become very critical often due to anthropogenic activities.

The most commonly encountered major air pollutants (primary and secondary) are:

- ✓ Tropospheric ozone (O<sub>3</sub>),
- ✓ Nitrogen oxides (NO<sub>x</sub>),
- ✓ Carbon monoxide (CO),
- ✓ Sulfur dioxide (SO<sub>2</sub>),
- ✓ Volatile organic compounds (VOCs),
- ✓ Polycyclic aromatic hydrocarbons (PAHs),
- ✓ Heavy metals (lead, cadmium, etc.),
- ✓ Suspended particulate matter.

When the gases are inhaled, 50% come out. Particles loaded with VOCs, bacteria, fungi, PAHs will settle throughout the respiratory system and the residence time will increase toxicity. Large particles (diameter > 10 μm), mainly of natural origin, have only a small impact on health: they settle very quickly on the ground or they are stopped at the level of the nose or swallowed. The assessment of their emissions and their concentration seems less useful for the protection of health (**MIRA, 2007**).

There are two types of particles:

Primary particles: directly emitted into the atmosphere.

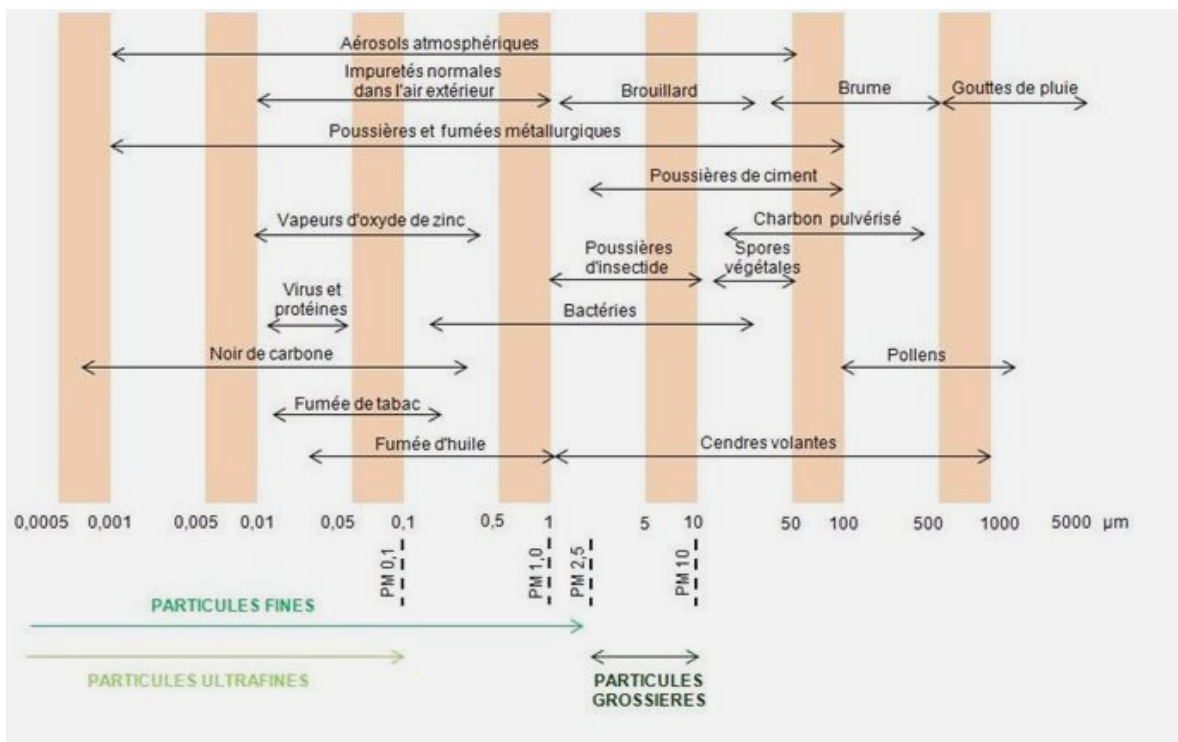
They mainly come from all incomplete combustions linked to industrial or domestic activities, as well as to transport. They are also emitted by agriculture (spreading organic manure, working the soil, etc.). They can also be of natural origin (soil erosion, pollens, biomass fires, etc.);

Secondary particles, formed in the atmosphere as a result of gas-particle conversions which may involve sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) or volatile organic compounds (VOCs), or even primary particles.

Particles are particularly harmful to health. They cause irritation and respiratory problems for sensitive people and are associated with an increase in mortality (respiratory diseases, cardiovascular diseases, cancers, etc.). They are also responsible for soiling on buildings and monuments.

We consider different particle sizes which are determined according to the aerodynamic diameter, hereinafter called "diameter":

- Total particles (PM): all the particles in the air;
- Fine particles (PM<sub>10</sub>): particles with a diameter of less than 10 µm;
- Very fine particles (PM<sub>2.5</sub>): particles with a diameter of less than 2.5 µm;
- Ultrafine particles (PM<sub>1</sub>): particles with a diameter of less than 1 µm;
- Nanoparticles (PM<sub>0.1</sub>): particles with a diameter of less than 0.1 µm.



**FIGURE 4: DISTRIBUTION OF THE DIFFERENT TYPES OF PARTICLES ACCORDING TO THEIR NATURE AND GRANULOMETRY**

The health risk linked to particle concentrations is real. In fact, according to the WHO, the risk of mortality, in the short term, increases by 2.5% for average daily concentrations greater

than 100 µg / m<sup>3</sup> for PM<sub>10</sub> and 50 µg / m<sup>3</sup> for PM<sub>2.5</sub>. This risk drops to 5% for concentrations above 150µg / m<sup>3</sup> for PM<sub>10</sub> and 75µg / m<sup>3</sup> for PM<sub>2.5</sub> (**WHO, 2005**). In the long term, the risk of mortality linked to prolonged exposure is 15% for annual average concentrations of 70µg / m<sup>3</sup> for PM<sub>10</sub> and 35µg / m<sup>3</sup> for PM<sub>2.5</sub>.

SO<sub>2</sub> is a colorless gas with a pungent odor. It is produced by the combustion of fossil fuels (coal and oil) and the smelting of iron ores containing sulfur. The main anthropogenic source of SO<sub>2</sub> is the combustion of sulfur-containing fossil fuels for domestic heating, electricity production or motor vehicles. SO<sub>2</sub> affects the respiratory system, the functioning of the lungs and it causes eye irritation. Inflammation of the respiratory system leads to coughing, mucus production, exacerbation of asthma, chronic bronchitis and sensitization to respiratory infections. The reaction with water produces sulfuric acid, the main component of acid rain that causes deforestation. Sulfur dioxide is even more corrosive and harmful when the concentration of particles and other pollutants is high.

NO<sub>x</sub> nitrogen oxides (NO + NO<sub>2</sub>) come essentially from the combustion of fossil fuels in high temperatures with reaction between nitrogen (N) and oxygen (O) and formation of nitrogen monoxide NO (**Schutz, 95**). At the outlet of vehicle exhaust pipes NO emissions represent almost 80% but very quickly transform into NO<sub>2</sub> in the atmosphere. Nitrogen oxides are involved in the formation of ozone, acidifying and eutrophying deposits (effects on soils, fauna and flora but also buildings) and by indirect effect in increasing the greenhouse effect. The health effects are now very well known, especially in asthmatics (worsening seizures) and children (slow development of lung function) (**WHO, 2005**).

This report provides an update on the objective of the study and its organization, as well as the parameters measured with the methodology used with the equipment used. The detailed results are presented in the annex with the tables and figures.

## 1. Objective of the performance tests

The objective of the measurement campaigns is to establish the baseline air quality situation at the village that could potentially be impacted by the future Malicounda diesel power station.

Specifically, it is a question of comparing the measurements carried out in the rules of the art with national regulations or, failing that, with good practices.

## 2. Reference standards

The atmospheric emission standards used are as follows:

- *Environmental, Health, and Safety Guidelines for Thermal Power Plants, IFC, December 2008*
- Senegalese standard NS 05-062 on air pollution, ASN, December 2004.

Note that the reference values used for the directives of standard NS-05-062 are those relating to a context of not degraded air quality.

**TABLE 1: APPLIED IMMISSION STANDARDS**

Pollutants	Type of average	Maximum Limit Value			
		WHO guidelines	NS-05-062 (Senegal)	US EPA (USA)	EU
<b>Sulfur dioxide (SO<sub>2</sub>)</b> (in µg / m <sup>3</sup> )	Timetable	500 (10 mn) 350 (1 heure)	-	200	350
	Daily	20	125		125
	Yearly	50	50		0.
<b>Nitrogen dioxide (NO<sub>2</sub>)</b> (in µg / m <sup>3</sup> )	Timetable	200	200	190	200
	Yearly	40		100	40
<b>Ozone (O<sub>3</sub>)</b> (in µg / m <sup>3</sup> )	Timetable 8 hours	- 100	- 120	150	
<b>Carbon monoxide (CO)</b> (in µg / m <sup>3</sup> )	Timetable	30 000			
	8 hours	10 000 30 000	26,19 ppm (30 mg/m <sup>3</sup> ) (24h)	40 000 (1h) 10 000 (8h)	10 000
<b>Particles &lt;10µm (PM<sub>10</sub>)</b> (in µg / m <sup>3</sup> )	Daily	50	260	150	50
	Yearly	20	80		20
<b>Particles &lt;2.5 µm (PM<sub>2.5</sub>)</b> (in µg / m <sup>3</sup> )	Daily	25	APPLIED WHO STANDARDS	35	
	Yearly	10		15	20
<b>Plomb (Pb)</b> (in µg / m <sup>3</sup> )	Yearly	500 ng/m <sup>3</sup>	2	5 ng/m <sup>3</sup>	500 ng/m <sup>3</sup>

## 2. MEASUREMENT METHODE

### 4.1. Quantification of NO<sub>2</sub> and SO<sub>2</sub> emissions in ambient air

The ambient air emission measurement was carried out using a measuring device consisting of a particle and gas detector. The data collected will be compared with the standards in force after processing. Insofar as we have measured over a period of 1 hour, we will use for this purpose the hourly standards of SO<sub>2</sub> from WHO and the hourly standard of NO<sub>2</sub> from Senegal.

The measurement of gaseous pollutants SO<sub>2</sub> and NO<sub>2</sub> was carried out by SKZ type gas detectors with good resolution at 0.01 ppm. In order to carry out this study, everything was carried out in relation to quality assurance and quality control procedures. For this reason, the analyzers have been supplied with a calibration certificate with the following characteristics:

- NO<sub>2</sub>: 0-20 ppm with a resolution of 0.01 ppm;
- SO<sub>2</sub>: 0-20 ppm with a resolution of 0.01 ppm;

The measuring device was placed at the airway height 1.7 m from the ground.

The scope of work and the materials used are presented below. In order to compare the data collected with the daily SO<sub>2</sub> and hourly NO<sub>2</sub> standards, measurements were made over a week and spread out at different times of the day. By this method we can more easily compare with the hourly NO<sub>2</sub> and daily SO<sub>2</sub> standards than with the annual standards. The

latter require long-term measures, which is not the case in our study, which is only the drawing up of the baseline situation.

**TABLE 2: SCOPE OF WORK**

POTENTIAL RECEIVERS	MEASUREMENT TIME	DATE (DD/MM/YYYY)
<b>Keur Maissa Faye</b>	08h25-09h25	05/09/2017
	12h35-13h35	06/09/2017
	15h08-16h08	07/09/2017
	10h54-11h54	08/09/2017
	17h03-18h03	09/09/2017
<b>Malicounda Solar Power station</b>	09h35-10h35	05/09/2017
	13h43-14h43	06/09/2017
	16h12-17h12	07/09/2017
	11h59-12h59	08/09/2017
	18h97-19h07	09/09/2017
<b>Darou Thioubene</b>	10h47-11h47	05/09/2017
	14h50-15h50	06/09/2017
	17h18-18h18	07/09/2017
	09h51-10h51	08/09/2017
	13h39-14h39	09/09/2017
<b>Keur Wally</b>	11h55-12h55	05/09/2017
	16h02-17h02	06/09/2017
	18h22-19h22	07/09/2017
	08h47-09h47	08/09/2017
	14h45-15h45	09/09/2017
<b>Malicounda Nguerigne</b>	13h12-14h12	05/09/2017
	17h14-18h14	06/09/2017
	10h34-11h34	07/09/2017
	17h42-18h42	08/09/2017
	09h06-10h06	09/09/2017
<b>Masseipe Mbengue</b>	14h25-15h25	05/09/2017
	11h26-12h26	06/09/2017
	09h24-10h24	07/09/2017
	16h36-17h36	08/09/2017
	15h54-16h54	09/09/2017
<b>NGOUKHOUDJ</b>	15h43-16h43	05/09/2017
	07h46-08h46	06/09/2017
	12h48-13h48	07/09/2017
	18h50-19h50	08/09/2017
	10h16-11h16	09/09/2017
<b>Malicounda Bambara</b>	17h-18h	05/09/2017
	10h15-11h15	06/09/2017
	19h32-20h32	07/09/2017
	15h26-16h26	08/09/2017
	12h30-13h30	09/09/2017
<b>Drilling / Malicounda Health District</b>	18h13-19h13	05/09/2017
	09h03-10h03	06/09/2017

Malicounda electrical station	14h-15h	07/09/2017
	13h10-14h10	08/09/2017
	11h25-12h25	09/09/2017
	18h22-19h22	06/09/2017
	11h40-12h	07/09/2017
	14h18-15h18	08/09/2017
	08h02-09h02	09/09/2017

**TABLE 3: MEASURING EQUIPMENT**

Location and measured items	Measuring tool	Detail	Technology
NO2 nitrogen dioxide	Maker	SKZ	Electrochemical cell
	Model Type, No.	SKZ 1050 online	
	Measuring Range	0 à 20 ppm	
	Resolution	0.01 ppm	
Sulfur dioxide SO2	Maker	SKZ	Electrochemical cell
	Model Type, No.	SKZ 1050 SO2	
	Measuring Range	0 à 20 ppm	
	Resolution	0.01 ppm	
PM2.5 and PM10	Maker	HAT/CEL	Laser detection
	Model Type, No.	HAT200S	
	Measuring Range	PM2.5 : 0 à 1000 µg/m3 PM10 : 0 à 2000 µg/m3	
	Resolution	1 µg/m3	
PM2.5	Marker	PAT+	ISO IWA 11 :2012 metrics
	Model Type, No.	PAT+	
	Measuring range	10-50 mg/m3	Gravimetry
	Resolution	10 µg/m3	

**FIGURE 5: PHOTOGRAPHS OF THE MEASUREMENT OF NO2, SO2 AND PM GAS POLLUTANTS AT THE LEVEL OF**









#### 4.2. PM2.5 and PM10 dust emission (PM) measurements in ambient air

In order to realize the actual PM concentrations in the atmosphere, particle monitoring was carried out directly at the potential receptors (villages).

PM2.5 was measured with a PATs + type dust analyzer, developed by the Berkeley Air Monitoring group and has the characteristics described in the table below:

- Measuring range: 10 - 50,000 µg / m<sup>3</sup> or 50 mg / m<sup>3</sup>;
- Resolution: 10 µg / m<sup>3</sup>;
- GPS location;
- Temperature and humidity.

Regarding PM10 measurements in ambient air, they were carried out according to the needs of the study using a device consisting of PATS + and HATS fine particle detectors.

#### Calibration or adjustment

PATS + measuring devices were calibrated to ensure the viability of the data collected. The PATS + has been calibrated twice and with a Zero and Range control. Zeroing involves injecting clean air into the chamber and removing any possible contamination that may have settled on the optical components inside the probe. To ensure the sensitivity of PATS +. The calibration was carried out in a special box or clean air is sent during the Zero adjustment. Also remember that the PATS is developed by the firm BARKELEY Air Monitoring Group which provides ISO IWA11: 2012 tests. A calibration certificate has been provided for reference.

#### 2.3 Location of air quality measurement points

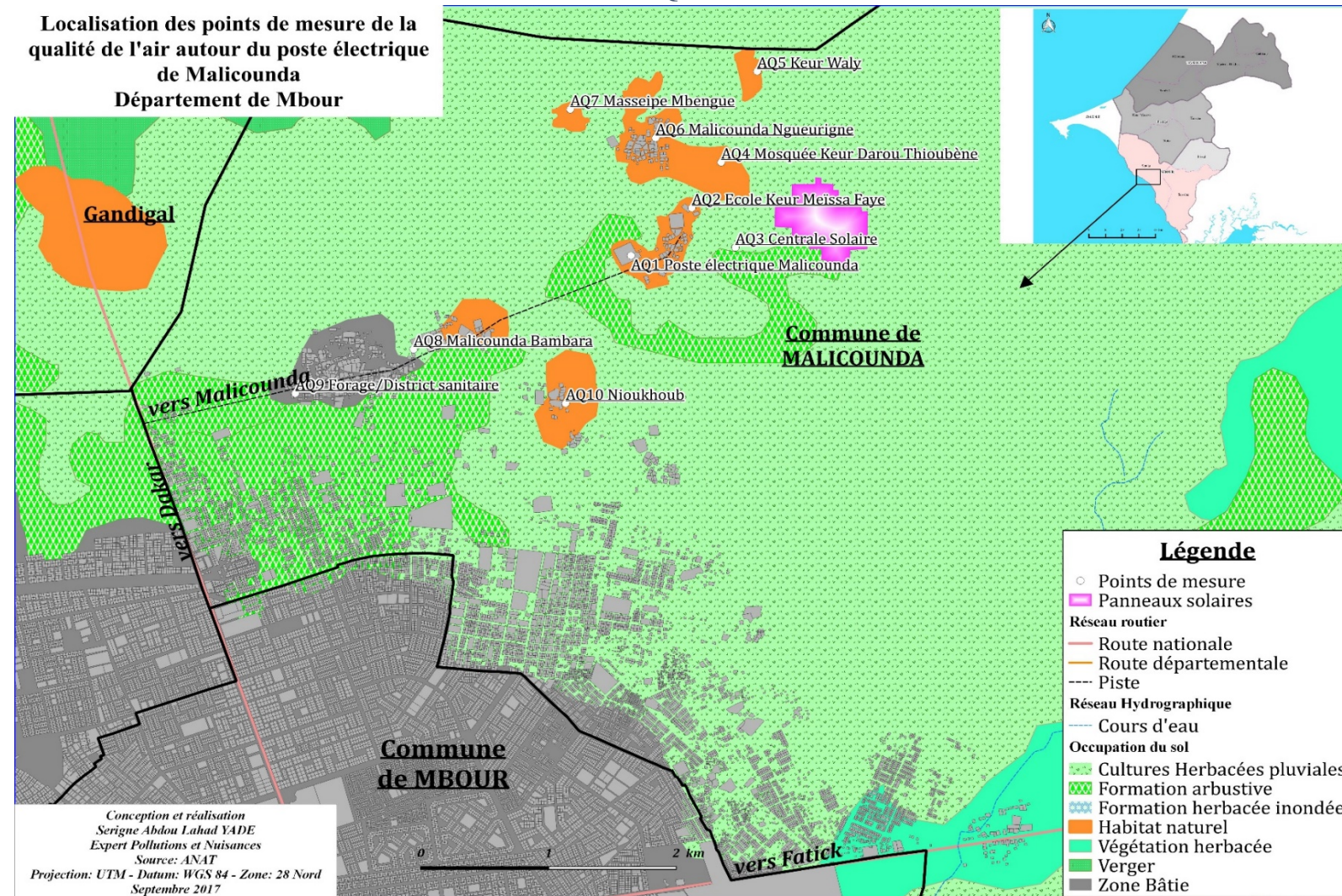
Table 4 shows the geographic location of the various ambient air quality measurement points.

**TABLE 4: GEOGRAPHICAL LOCATION OF AMBIENT AIR QUALITY MEASUREMENT SITES**

Location Air Ambient measurement point in Malicounda	
UTM information	Measuring points
X 289857 Y 1600660	AQ1 : Malicounda Electric station
X 290333 Y 1601054	AQ2 : keur maissa faye school
X 290681 Y 1600727	AQ3 : Malicounda solar power station
X 290563 Y 1601432	AQ4 : Mosque Keur Darou Thioubene
X 290845 Y 1602185	AQ5 : Keur wally
X 290050 Y 1601634	AQ6 : Malicounda Nguerigne
X 289381 Y 1601870	AQ7 : Masseipe Mbengue

<b>X 288154</b> <b>Y 1599884</b>	AQ8 : Malicounda Bambara
<b>X 2872283</b> <b>Y1599518</b>	AQ9 : Drilling/health district
<b>X 289345</b> <b>Y 1599436</b>	AQ10 : NGOUKHOUDJ

**FIGURE 6: GEOGRAPHICAL REPRESENTATION OF AIR QUALITY MEASUREMENT POINTS**



### 3. Presentation of the results of air emissions

#### 5.1 NO<sub>2</sub> and SO<sub>2</sub> emissions at potential receptors

**TABLE 5: CLIMATOLOGY OF MBOUR (SOURCE: ANACIM)**

CLIMATOLOGY MBOUR FROM 05 TO 09 SEPTEMBER 2017: DAILY DATA						
DATES	Temperature in °C	Humidity mini in %	Humidity maxi in %	Wind direction	Wind speed in m / s	Rainfall in mm
5	27.3	66	100	NE	4.0	.
6	28.0	72	93	NE	4.0	.
7	29.1	71	85	SW	4.0	0.5
8	27.0	75	98	NE	2.0	0.3
9	29.0	67	94	NW	3.0	.

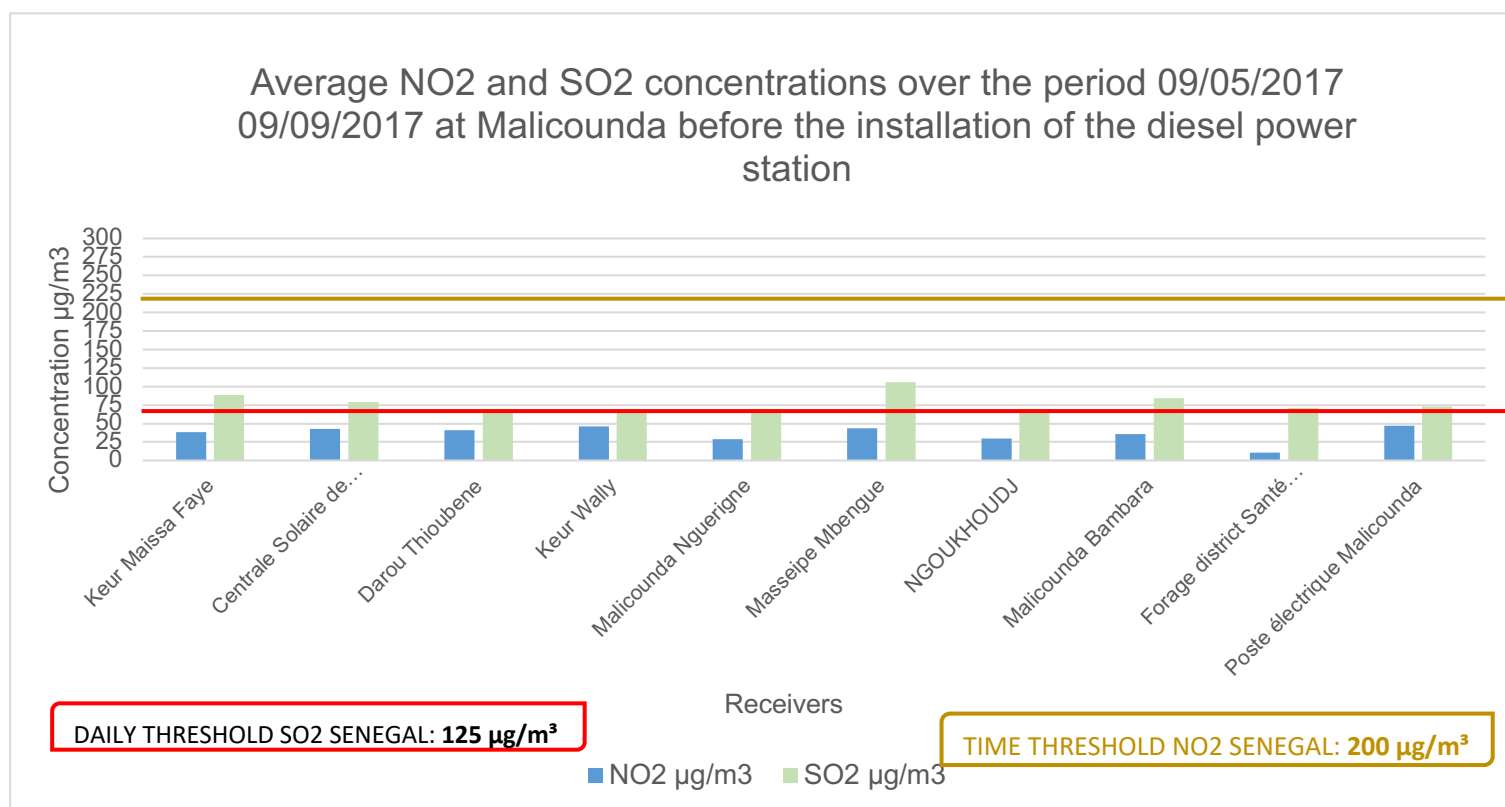
**TABLE 6 : CONCENTRATION OF NO<sub>2</sub> AND SO<sub>2</sub> GAS POLLUTANTS ON IMMISSION AT THE POTENTIAL RECEPTOR LEVEL**

Date	Location	NO <sub>2</sub> µg/m <sup>3</sup>	SO <sub>2</sub> µg/m <sup>3</sup>	Observation
05 to 09/09/2017	Keur Maissa Faye	38.24	88.07	- less 20% at the NO <sub>2</sub> limit - Less than 70% at the limit of SO <sub>2</sub>
	Malicounda solar power station	42.79	78.62	- Less than 22% at the NO <sub>2</sub> limit - Less than 63% at the limit of SO <sub>2</sub>
	Darou Thioubene	41.34	68.64	-Less than 21% at the NO <sub>2</sub> limit - Less than 55% at the limit of SO <sub>2</sub>
	Keur Wally	46.34	64.24	- Less than 24% at the NO <sub>2</sub> limit - Less than 55% at the limit of SO <sub>2</sub>
	Malicounda Nguerigne	29.22	68.31	- Less than 15% at the NO <sub>2</sub> limit -Less than 55% at the limit of SO <sub>2</sub>
	Masseipe Mbengue	43.38	105.74	- Less than 22% at the NO <sub>2</sub> limit



				- Less than 85% at the limit of SO2
				- Less than 15% at the NO2 limit -Less than 56% at the limit of SO2
	<b>NGOUKHOUDJ</b>	29.40	69.56	-Less than 18% at the NO2 limit -Less than 68% at the limit of SO2
	<b>Malicounda Bambara</b>	35.89	83.78	- Less than 6% at the NO2 limit -Less than 58% at the limit of SO2
	<b>Drilling district Malicounda Health</b>	10.86	71.49	-Less than 24% at the NO2 limit -Less than 59% at the limit of SO2
	<b>Malicounda electrical station</b>	47.37	72.9	

**FIGURE 7: AVERAGE SO2 AND NO2 CONCENTRATIONS AT THE POTENTIAL RECEPTOR LEVEL AT THE DIESEL STATION IN MALICOUNDA**



The average concentrations of gaseous pollutants NO<sub>2</sub> and SO<sub>2</sub> measured at the intake remained well below the standards in force in Senegal. However, it is important to report the effectiveness of micro-traffic on Malicounda level for the transport of populations and in relation to the various projects identified in said locality with NO<sub>2</sub> emissions especially without having a negative impact on the quality of the air.

Overall, the NO<sub>2</sub> and SO<sub>2</sub> concentrations at the measurement sites do not vary significantly from one receptor to another. And the absence of a major source of air pollution in the area could largely explain these low concentrations compared to the standards in force. However, the SO<sub>2</sub> levels are closer to the Senegalese limit (Table 7). NO<sub>2</sub> concentrations of less than 25% are observed at the permissible limit and SO<sub>2</sub> levels closer to the limit are only less than 60%. The maximum recorded in the project area for SO<sub>2</sub> is at Masseipe Mbengue with 105.74 µg / m<sup>3</sup>.

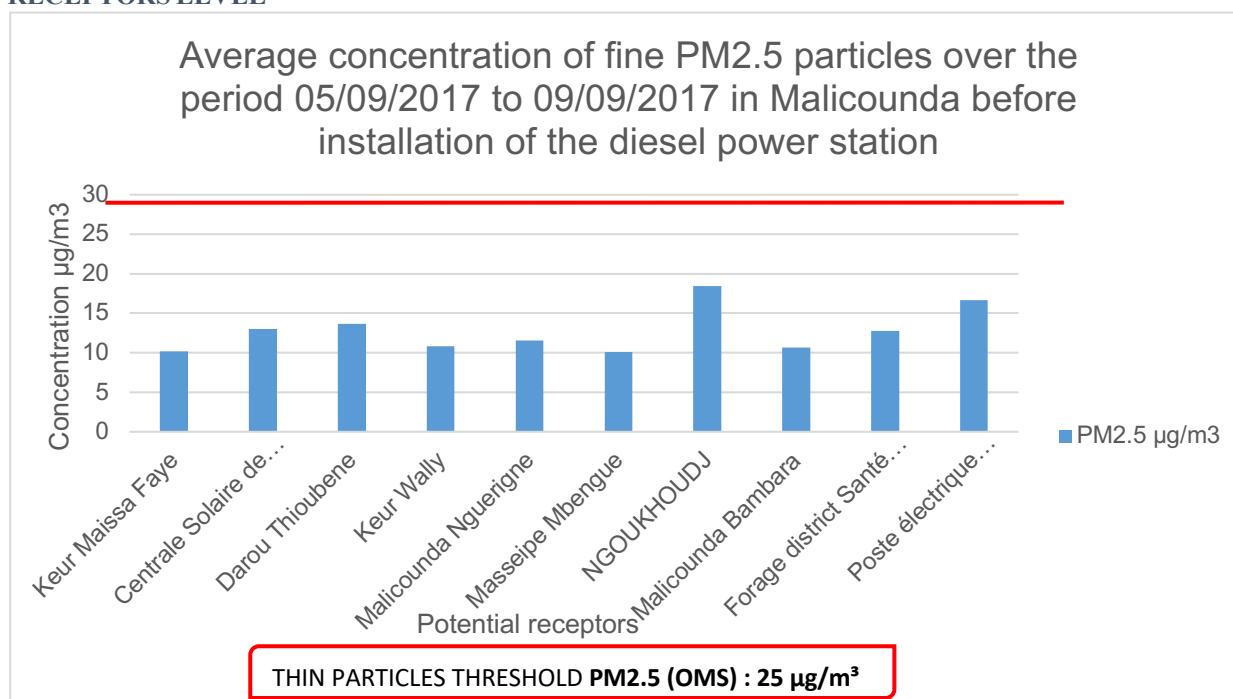
Micro-climatic conditions also contributed to lower pollution levels at the time of the measures. In the presence of high humidity, the fixed water can become the majority constituent of the hydrophilic aerosol, which can cause the modification of its composition and consequently of its optical properties. However, the sulfur content increases the hydrophilic nature of the particles which fix all the pollutants present in the atmosphere. The hydrophilic nature of the particles designates their capacity to absorb water. In the presence of high humidity, the fixed water can become the majority constituent of the hydrophilic aerosol, which can cause the modification of its composition and consequently of its optical properties. Therefore, by fixing more water, the particles increase in mass and naturally will sediment. By sedimenting water, they decrease their concentrations in addition to those of the gaseous pollutants that they fix on their surfaces. The climate has a notable influence on the dynamics of dispersion of particles in the atmosphere.

## 5.2 Concentration of PM in ambient air at the level of potential receptors

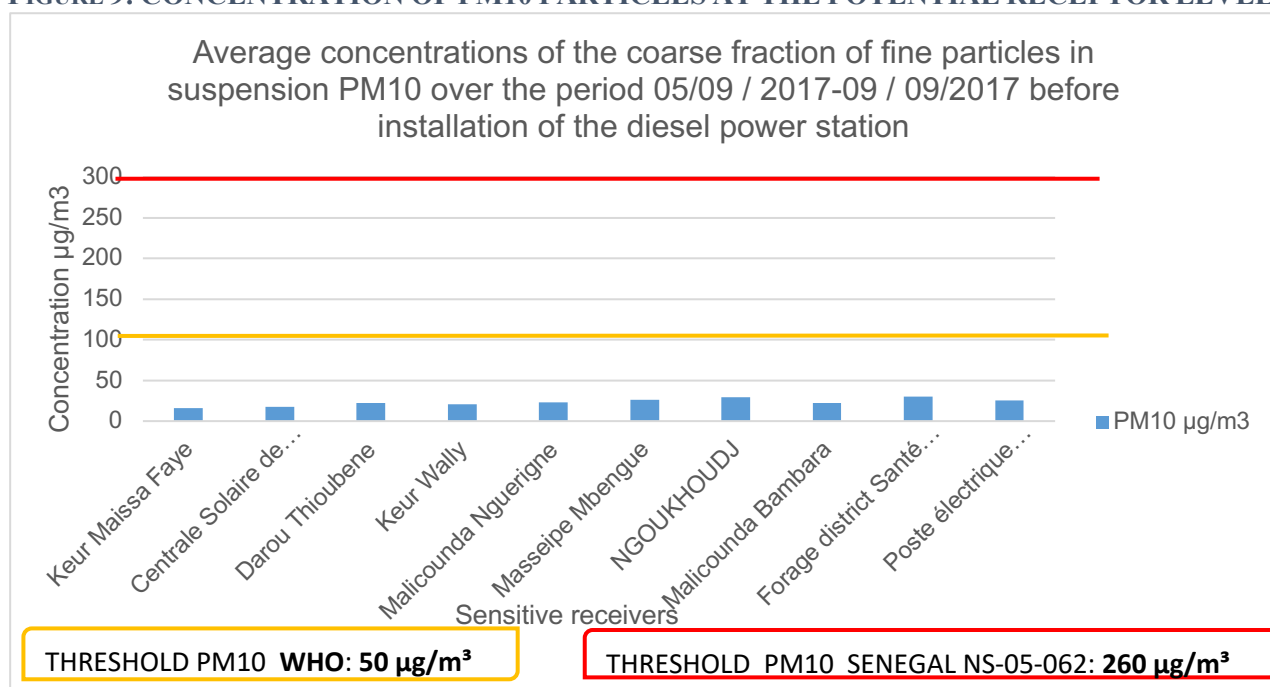
**TABLE 7: CONCENTRATION OF PM<sub>2.5</sub> AND PM<sub>10</sub> PARTICULATE POLLUTANTS ON IMMISSION TO POTENTIAL RECEPTORS**

Date	Location	PM <sub>2.5</sub> µg/m <sup>3</sup>	PM <sub>10</sub> µg/m <sup>3</sup>
05 to 09/09/2017	Keur Maissa Faye	10.2	16.34
	Malicounda solar power station	13.04	17.28
	Darou Thioubene	13.63	22.28
	Keur Wally	10.852	20.67
	Malicounda Nguerigne	11.556	23.04
	Masseipe Mbengue	10.118	26.45
	NGOUKHOUDJ	18.424	29.73
	Malicounda Bambara	10.6775	22.42
	Drilling Health district Malicounda	12.758	30.1
	Malicounda electrical station	16.645	25.32

**FIGURE 8: CONCENTRATION OF PM2.5 PARTICLES ON IMMISSION AT THE POTENTIAL RECEPTORS LEVEL**



**FIGURE 9: CONCENTRATION OF PM10 PARTICLES AT THE POTENTIAL RECEPTOR LEVEL**



The average daily concentrations of PM2.5 and PM10 remained to a great extent below the standards in force. The absence of a major source of air pollution and favorable climatic conditions greatly contributed to lowering the levels of PM in suspension in the project area. At this stage of the project,

the levels of PM<sub>10</sub> and PM<sub>2.5</sub> suspended particles in the different localities do not vary from one site to another as illustrated in Figures 9 and 10. The PM<sub>10</sub> remained as well below the norm of the WHO and far away to the norm of Senegal. The highly noted use of biomass in households has not really deteriorated air quality in the area. To this should also be added the fact that we are in the rainy season and that the high humidity at the time of measurements, most often combined with a certain hydrophilicity of aerosols, can considerably lower their concentration in the atmosphere. It is important to understand the fact that PM<sub>10</sub> remains generally of natural origin (mineral erosion) and more or less of anthropogenic origin (wear of tires, pavement, brake linings). Their evolution in the atmosphere is very strongly linked to climatic conditions and especially with the wind and humidity which can either favor their mobilization or their sedimentation. In our study it is important to note high humidity (table 6) and an average wind speed. Consequently, the water fixed by the particles which are not so mobilized, will favor their sedimentation and lower their concentration. This could largely explain the low levels of PM encountered in the area at the time of the measurements. With regard to PM<sub>2.5</sub>, which is mainly of anthropogenic origin (combustion waste, condensation and nucleation), the absence of a major source of air pollution in the project area explains to some extent the very low concentrations obtained during monitoring.

The mineral component ( $\text{NO}_3^-$ ,  $\text{NH}_4^+$ ,  $\text{Na}^+$ , etc.) is generally responsible for the hydrophilic properties of the aerosol (Saxena and al. 1995). Thus, particles of marine origin or particles with a high sulfur content are highly hydrophilic. On the contrary, organic compounds, mainly of primary origin, such as alkanes, alkenes and organic acids, are generally hydrophobic. However, the presence of organic compounds in the aerosol can modify its hygroscopic power. According to Saxena, their presence in the aerosol would considerably increase the mass of water fixed by the particle for ambient humidity exceeding 80%.



#### 4. Conclusion

The campaign to measure atmospheric emissions at the various sites that could potentially have an impact on the future Malicounda diesel power station made it possible to assess air quality there. The result of the air quality is fairly good with pollution levels well below national and international standards. The concentrations of gaseous pollutants NO<sub>2</sub> / SO<sub>2</sub> and particulate PM<sub>2.5</sub> and PM<sub>10</sub> measured at the different sites have remained very low and do not vary much from one site to another. And this fact confirms the absence of any significant source of air pollution in Malicounda area. However, there are tendencies in SO<sub>2</sub> closer to the Senegalese limit, probably due to the heavy use of solid fuels as an energy source in most households and also in traffic. The risk of pollution is very minor at present in Malicounda with weather conditions favorable to the leaching of aerosols in the atmosphere. The effectiveness of such a project could considerably deteriorate air quality if measures are not taken prior to the construction and operation phases. Monitoring air quality is essential over time and space.

#### 5. Recommendations

- Disposer de filtres particuliers et moléculaires dans les cheminées en phase d'exploitation
- Evaluate the air quality in the area of influence of the project during the construction phase
- Ensure long-term monitoring of ambient air quality in the various sites listed as potential receptors; NO<sub>2</sub>, SO<sub>2</sub> and PM monitoring (PM<sub>2.5</sub> and PM<sub>10</sub>)
- Monitoring NO<sub>x</sub> SO<sub>2</sub> and PM atmospheric emissions during the operational phase at the chimneys
- Ensure the use of good quality fuel during the operating phase with a sulfur content of less than 2%.
- Model the dispersion of pollutants at the chimney outlet according to the characteristics of the engines that will be used.
- Having particulate and molecular filters in the chimneys during the operating phase.

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## ANNEXE



**BERKELEY AIR**  
MONITORING GROUP

*protecting health and climate*

Serigne Abdoul Lahad Yade  
Toxicologist  
Direction de l'Environnement et des établissements classes  
Centre de Gestion de la Qualité de l'Air

Dear Serigne,

Let this serve as certification that your PATS+ device number 7357 has been calibrated.  
Thank you very much

Best Regards,

Kara Fleisher  
Business Manager  
Berkeley Air Monitoring Group

Berkeley Air Monitoring Group | 1900 Addison St. #350 Berkeley, CA 94704 | Office phone: +1 510.649.9355 | FAX: +1 510.662.1970

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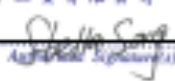
The eu compliance

### Calibration Certification

Model: HAT200S		Customer:		
Code No:		Date of issue: 18 <sup>th</sup> , May, 2017		
Warranty Period: 12 months		Post-production service: 12 months		
Test report				
No.	Standard Value	Measured value	After calibration	Remark
1	250mg/m <sup>3</sup>	249mg/m <sup>3</sup>	250mg/m <sup>3</sup>	Qualified
2	500mg/m <sup>3</sup>	498mg/m <sup>3</sup>	500mg/m <sup>3</sup>	Qualified
We Certified that this detector has been inspected and calibrated, serviced and calibrated in accordance to manufacturer's (SKZ Industrial Co., Ltd) specification.				
Signature				
For and on behalf of SKZ INDUSTRIAL CO., LIMITED 山东康平工贸有限公司				
Stamp				
..... Stella Song Authorized Supervisor				



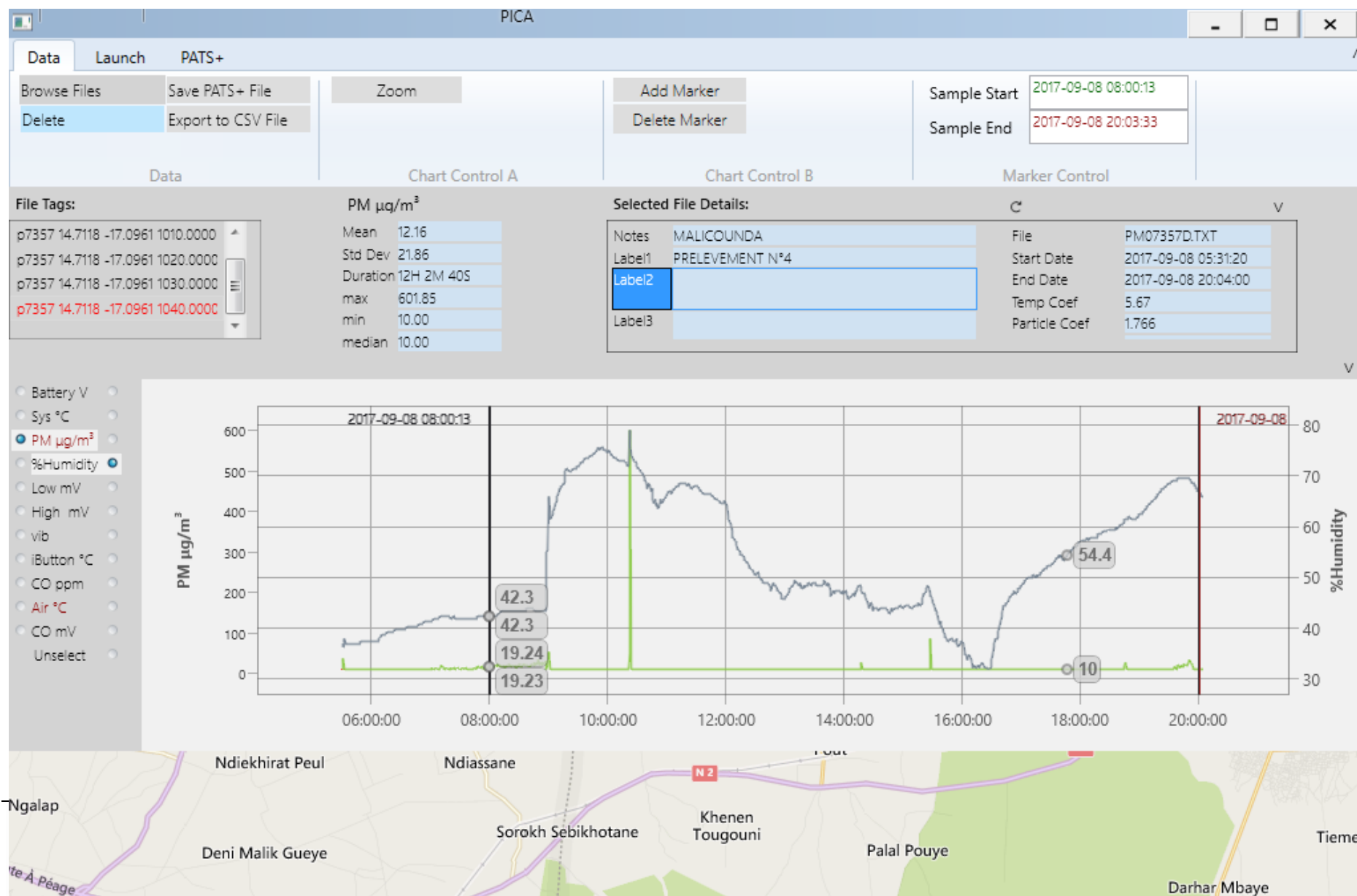
## CALIBRATION CERTIFICATE

Model: SKZ1050-SO2		Customer:				
Serial NO:		Date of issue: 2017.06				
Warranty Period: 12 months		Next Calibration: 2018.01				
Version NO: V4.5						
<b>Test Report</b>						
1.This instrument has been examined, the setup is qualified.						
2. Calibration of sensor is qualified.						
3.This instrument works properly and allowing release						
<b>Calibration</b>						
<b>Measurement Unit</b>						
No.	Standard gas	Standard gas concentration	Value before calibration	Value after calibration	Response time	Remark
1	SO2	19.8PPM	20.32PPM	19.81PPM	<30second	
<b>Certification</b>						
We hereby certify that this equipment is qualified.						
For and on behalf of SKZ INDUSTRIAL CO., LIMITED Stamp: 山东康平工贸有限公司  Authorized Representative						

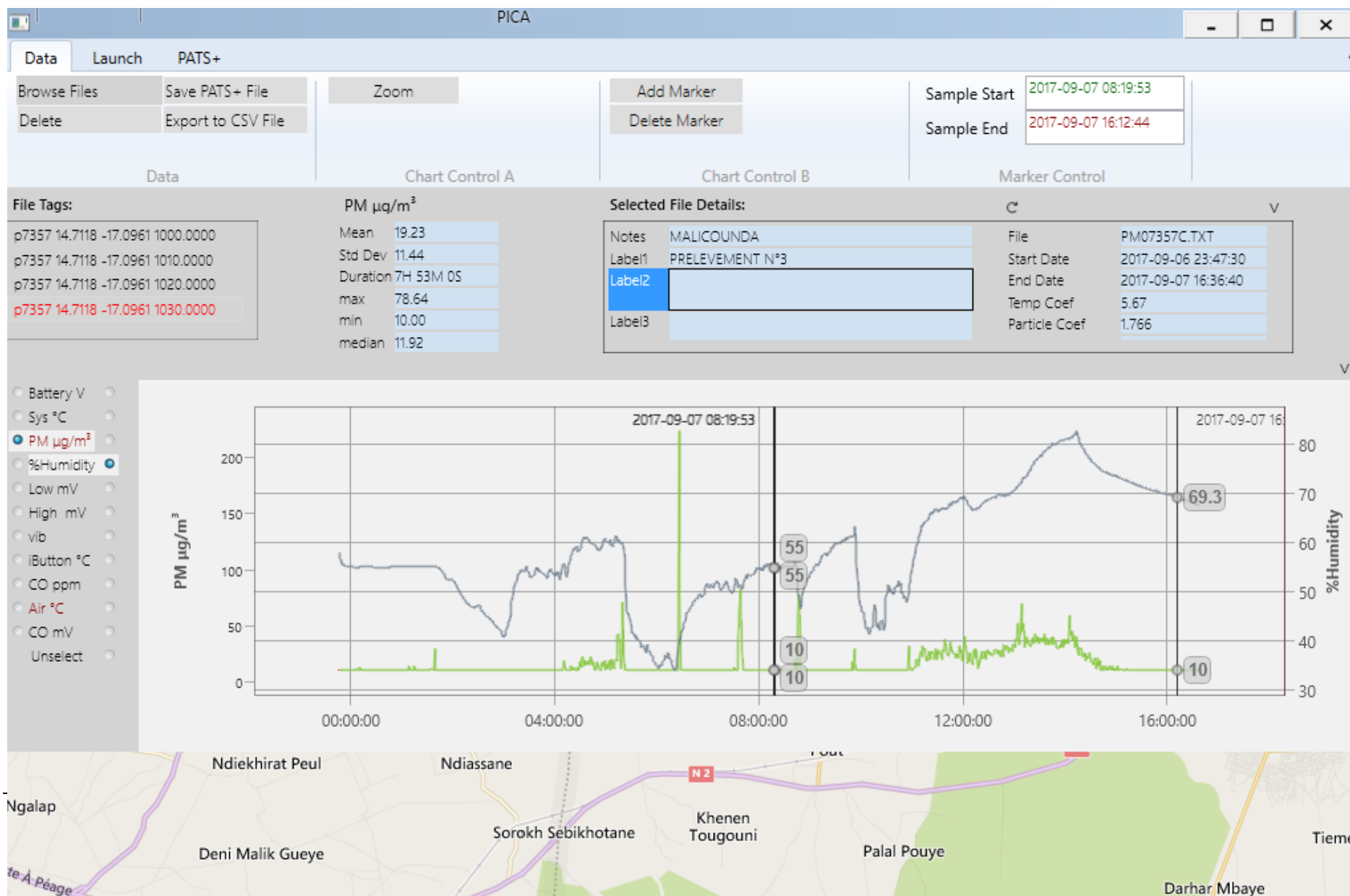


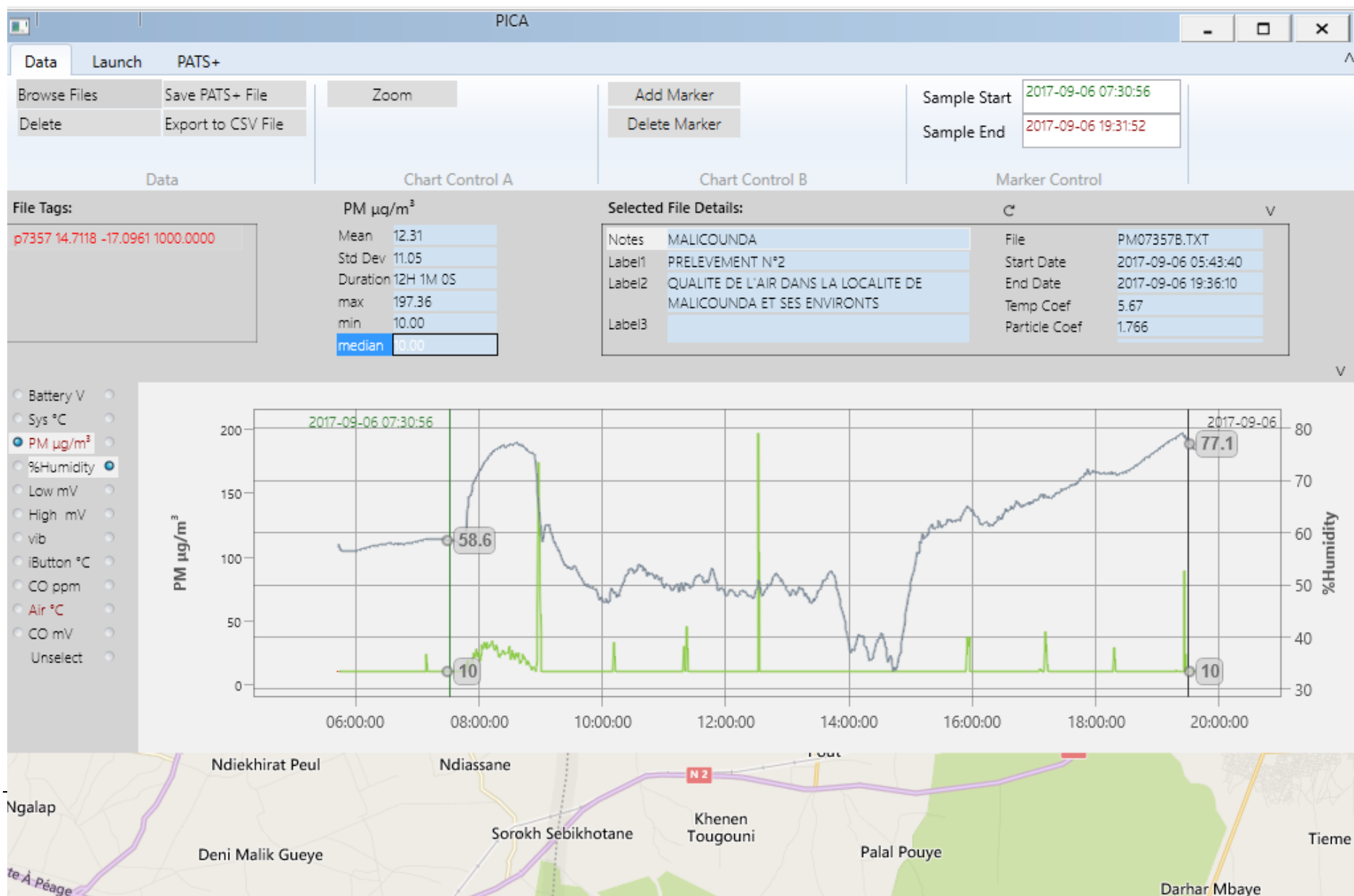
## CALIBRATION CERTIFICATE

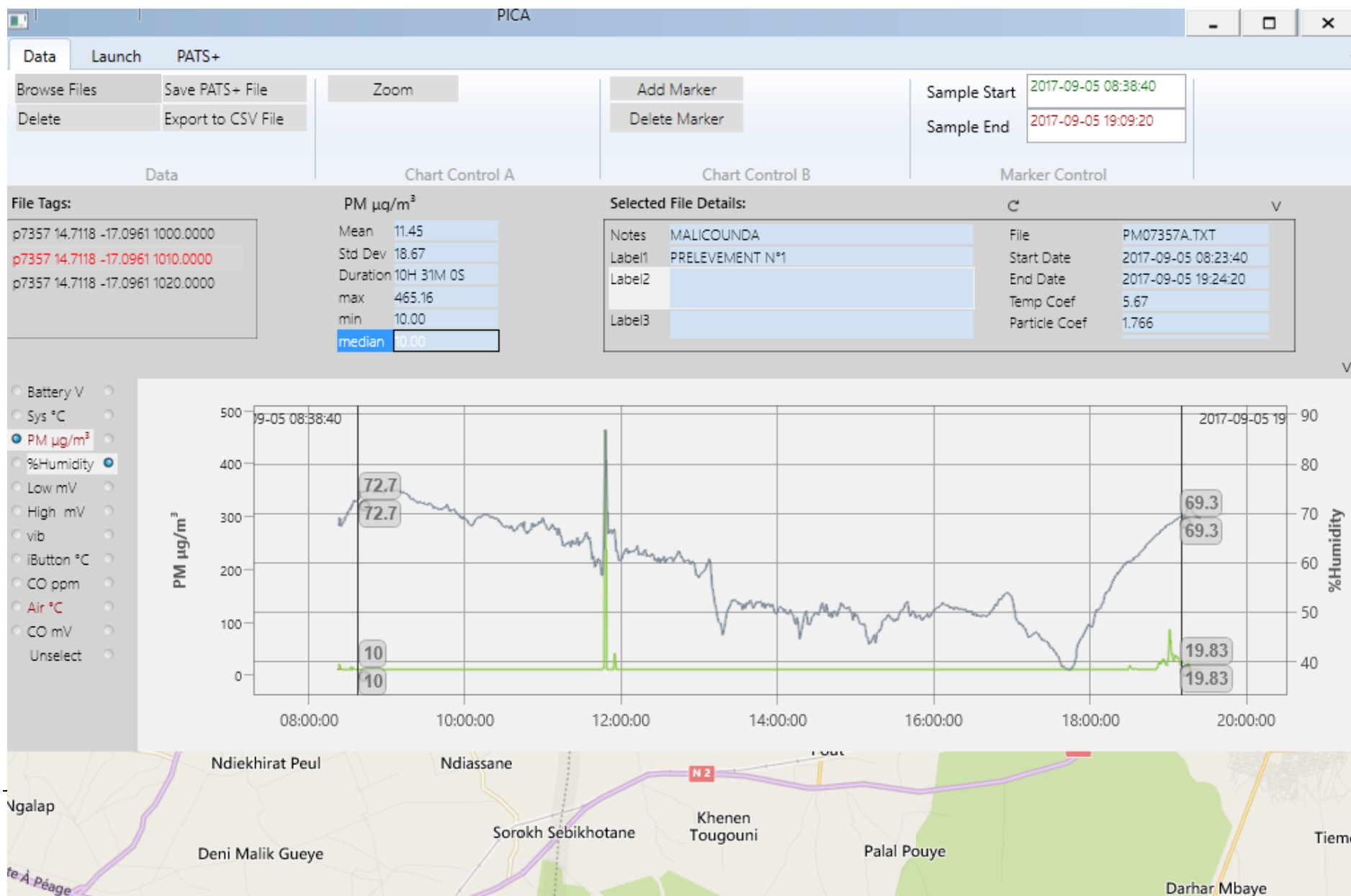
<b>Model:</b> SKZ1050B (NO2)		<b>Customer:</b>				
<b>Serial NO:</b>		<b>Date of issue:</b> 2017.03				
<b>Warranty Period:</b> 1 year		<b>Next Calibration:</b> 2018.03				
<b>Version NO:</b> V4.5						
<b>Test Report</b>						
1.This instrument has been examined, the setup is qualified.						
2. Calibration of sensor is qualified.						
3.This instrument works properly and allowing release						
<b>Calibration</b>						
<b>Measurement Unit</b>						
No.	Standard gas	Standard gas concentration	Value before calibration	Value after calibration	Response time	Remark
1	NO2	50PPM	49.98PPM	50.01PPM	<30second	
<b>Certification</b>						
We hereby certify that this equipment is qualified.						
<p>For and on behalf of SKZ INDUSTRIAL CO., LIMITED Stamp: 山东康卓工贸有限公司</p> <p><i>Shella Song</i> Authorized Signature(s)</p>						

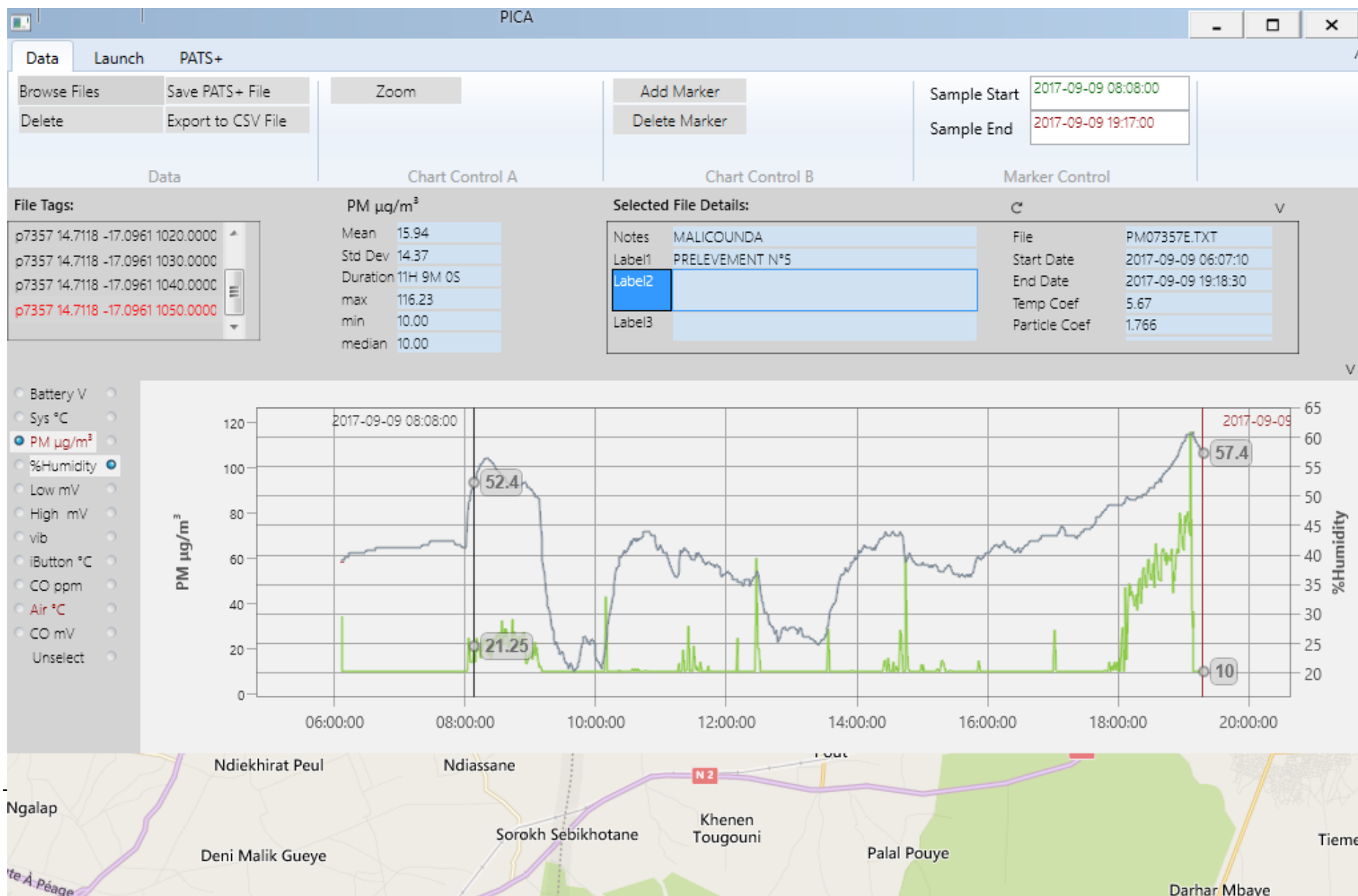












Date	Location	NO2 µg/m3	PM2.5 µg/m3	PM10 µg/m3	SO2 µg/m3	Time of measure
05/09/2017	Keur Maissa faye		10	14	98.9041096	08h25-09h25
06/09/2017	Keur Maissa faye	39.14	10	19.32	122.089552	12h35-13h35
07/09/2017	Keur Maissa faye	43.01	10.03	14.5	94.1176471	15h08-16h08
08/09/2017	Keur Maissa faye	7	10	8.19	43.5820896	10h54-11h54
09/09/2017	Keur Maissa faye	63.82	10.97	25.7	81.6666667	17h03-18h03
	<b>K.M. Faye Average</b>	<b>38.2425</b>	<b>10.2</b>	<b>16.342</b>	<b>88.072013</b>	
05/09/2017	Malicounda solar station	NV	11.45	6	80.4615385	09h35-10h35
06/09/2017	Malicounda solar station	40.16	10	12.51612903	109.558824	13h43-14h43
07/09/2017	Malicounda solar station	48.98	10	16.4516129	84.8387097	16h12-17h12
08/09/2017	Malicounda solar station	11.51	10	4.193548387	51.7910448	11h59-12h59
09/09/2017	Malicounda solar station	70.54	23.75	47.25806452	66.4516129	18h97-19h07
	<b>Malicounda solar station Average</b>	<b>42.7975</b>	<b>13.04</b>	<b>17.28387097</b>	<b>78.6203459</b>	
05/09/2017	Darou Thioubene		17.44	7.85	6.02941176	10h47-11h47
06/09/2017	Darou Thioubene	21.88	10	30.77	98.5294118	14h50-15h50
07/09/2017	Darou Thioubene	49.25	10	23.64	84.3076923	17h18-18h18
08/09/2017	Darou Thioubene	27.47	20.01	13.88	47.0149254	09h51-10h51
09/09/2017	Darou Thioubene	66.77	10.7	35.29	107.352941	13h39-14h39
	<b>Darou Thioubene Average</b>	<b>41.3425</b>	<b>13.63</b>	<b>22.286</b>	<b>68.6468765</b>	
05/09/2017	Keur Wally		10	5	30	11h55-12h55
06/09/2017	Keur Wally	41.61	10	19.48	89.2647059	16h02-17h02
07/09/2017	Keur Wally	51.88	10	41.25	71.5625	18h22-19h22
08/09/2017	Keur Wally	29.62	13.69	2.35	42.7536232	08h47-09h47

09/09/2017	Keur Wally	62.25	10.57	35.29	87.6470588	14h45-15h45
	<b>Keur Wally Average</b>	<b>46.34</b>	<b>10.852</b>	<b>20.674</b>	<b>64.2455776</b>	
05/09/2017	Malicounda Nguerigne		10	8	35.8208955	13h12-14h12
06/09/2017	Malicounda Nguerigne	7.31	10	26	72.6153846	17h14-18h14
07/09/2017	Malicounda Nguerigne	52.25	17.52	28.83	111.940299	10h34-11h34
08/09/2017	Malicounda Nguerigne	35.8	10.08	16.16	52.2222222	17h42-18h42
09/09/2017	Malicounda Nguerigne	21.55	10.18	36.22	68.9552239	09h06-10h06
	<b>M. Nguerigne Average</b>	<b>29.2275</b>	<b>11.556</b>	<b>23.042</b>	<b>68.3108049</b>	
05/09/2017	Masseipe Mbengue		10	8	56.4179104	14h25-15h25
06/09/2017	Masseipe Mbengue	17.09	10	44.93	134.852941	11h26-12h26
07/09/2017	Masseipe Mbengue	34.64	10.59	36.34	165	09h24-10h24
08/09/2017	Masseipe Mbengue	61.72	10	13.64	86.7647059	16h36-17h36
09/09/2017	Masseipe Mbengue	60.1	10	29.38	85.6716418	15h54-16h54
	<b>M. Mbengue Average</b>	<b>43.3875</b>	<b>10.118</b>	<b>26.458</b>	<b>105.74144</b>	
05/09/2017	NGOUKHOUDJ		10	9	65.6716418	15h43-16h43
06/09/2017	NGOUKHOUDJ	10.67	23.85	35.9	5.16666667	07h46-08h46
07/09/2017	NGOUKHOUDJ	45.5	36.32	36.7	115.882353	12h48-13h48
08/09/2017	NGOUKHOUDJ	42.58	11.8	26.7	72.5641026	18h50-19h50
09/09/2017	NGOUKHOUDJ	18.87	10.15	40.38	88.5294118	10h16-11h16
	<b>NGOUKHOUDJ Average</b>	<b>29.405</b>	<b>18.424</b>	<b>29.736</b>	<b>69.5628351</b>	
05/09/2017	Malicounda Bambara		11.45	13.85	48.6764706	17h-18h
06/09/2017	Malicounda Bambara	33.44	10	11.96	100	10h15-11h15

07/09/2017	Malicounda Bambara	46.88		48.41	64.2622951	19h32-20h32
08/09/2017	Malicounda Bambara	27.95	11.26	7.94	87.0149254	15h26-16h26
09/09/2017	Malicounda Bambara	35.32	10	29.96	118.955224	12h30-13h30
	<b>M. Bambara Average</b>	<b>35.8975</b>	<b>10.6775</b>	<b>22.424</b>	<b>83.781783</b>	
05/09/2017	Drilling/ Malicounda Heath district		11.45	57.71	32.8070175	18h13-19h13
06/09/2017	Drilling/ Malicounda Heath district	19.25	10	18.93	69.4117647	09h03-10h03
07/09/2017	Drilling/ Malicounda Heath district	5.24	21.65	18.77	94.1176471	14h-15h
08/09/2017	Drilling/ Malicounda Heath district	1.61	10	24.48	62.6470588	13h10-14h10
09/09/2017	Drilling/ Malicounda Heath district	17.35	10.69	30.61	98.5074627	11h25-12h25
	<b>D and Health district Average</b>	<b>10.8625</b>	<b>12.758</b>	<b>30.1</b>	<b>71.4981902</b>	
05/09/2017	Electrical station				NV	NV
06/09/2017	Electrical station	81.56	10.03	18.8	68.030303	18h22-19h22
07/09/2017	Electrical station	37.63	24.66	12.54	118.507463	11h40-12h
08/09/2017	Electrical station	32.31	10	7.54	69.7014925	14h18-15h18
09/09/2017	Electrical station	38.01	21.89	62.41	35.3846154	08h02-09h02
	<b>Electrical station Average</b>	<b>47.3775</b>	<b>16.645</b>	<b>25.3225</b>	<b>72.9059684</b>	

Malicounda Nguerigne					Keur Maissa Faye					Malicounda Solar station			
DATE	TIME	PM10	NO2 µg/m3	Date	TIME	PM10	NO2 µg/m3	Date	TIME	PM10	NO2 µg/m3		
05/09/2017	13H12	12	-	05/09/2017	8H25	10	-	05/09/2017	9H35	12	-		
	13H15	10	-		8H28	7	-		9H38	9	-		
	13H18	9	-		8H31	10	-		9H41	10	-		
	13H21	6	-		8H34	10	-		9H44	9	-		
	13H24	7	-		8H37	15	-		9H47	9	-		
	13H27	8	-		8H40	11	-		9H50	9	-		
	13H30	7	-		8H43	23	-		9H53	10	-		
	13H33	7	-		8H46	35	-		9H56	7	-		
	13H36	8	-		8H49	18	-		9H59	5	-		
	13H39	8	-		8H52	14	-		10H02	5	-		
	13H42	5	-		8H55	15	-		10H05	5	-		
	13H45	20	-		8H58	13	-		10H08	5	-		
	13H48	7	-		9H01	14	-		10H11	5	-		
	13H51	7	-		9H04	13	-		10H14	5	-		
	13H54	8	-		9H07	11	-		10H17	5	-		
	13H57	7	-		9H10	14	-		10H20	5	-		
	14H00	8	-		9H13	15	-		10H23	5	-		
	14H03	8	-		9H16	17	-		10H26	5	-		
	14H06	8	-		9H19	15	-		10H29	5	-		
	14H09	7	-		9H22	13	-		10H32	5	-		
	14H12	8	-		9H25	17	-		10H35	5	-		
		8.33333333	-			14.7619048	-			6.66666667	-		



06/09/2017			-	06/09/2017			-	06/09/2017			-		
	17:14	18	8.33		12:35	16	-		13:43	11	33.33		
	17:16	23	11.67		12:37	18	26.67		13:45	14	33.33		
	17:18	19	11.67		12:39	21	31.67		13:47	15	40.00		
	17:20	20	10.00		12:41	28	36.67		13:49	14	41.67		
	17:22	22	11.67		12:43	16	38.33		13:51	11	46.67		
	17:24	27	11.67		12:45	14	56.67		13:53	12	31.67		
	17:26	26	8.33		12:47	17	58.33		13:55	13	41.67		
	17:28	26	15.00		12:49	14	51.67		13:57	12	46.67		
	17:30	31	33.33		12:51	15	50.00		13:59	12	55.00		
	17:32	28	11.67		12:53	13	53.33		14:01	12	41.67		
	17:34	22	11.67		12:55	14	46.67		14:03	11	31.67		
	17:36	37	15.00		12:57	13	55.00		14:05	12	25.00		
	17:38	24	13.33		12:59	13	56.67		14:07	12	26.67		
	17:40	25	16.67		13:01	14	50.00		14:09	12	28.33		
	17:42	23	15.00		13:03	14	58.33		14:11	12	40.00		
	17:44	50	15.00		13:05	14	48.33		14:13	12	36.67		
	17:46	48	150.00		13:07	19	53.33		14:15	11	33.33		
	17:48	21	16.67		13:09	14	48.33		14:17	12	46.67		
	17:50	26	13.33		13:11	18	38.33		14:19	11	28.33		
	17:52	30	13.33		13:13	69	36.67		14:21	11	40.00		
	17:54	23	15.00		13:15	21	31.67		14:23	11	45.00		
	17:56	33	15.00		13:17	29	-		14:25	11	53.33		
	17:58	21	15.00		13:19	26	-		14:27	11	43.33		
	18:00	23	8.33		13:21	29	25.00		14:29	11	46.67		
	18:02	22	11.67		13:23	14	-		14:31	12	51.67		

	18:04	21	13.33		13:25	32	26.67		14:33	14	31.67	
	18:06	22	10.00		13:27	14	28.33		14:35	12	38.33	
	18:08	20	8.33		13:29	18	26.67		14:37	11	41.67	
	18:10	22	10.00		13:31	15	31.67		14:39	15	60.00	
	18:12	27	8.33		13:33	12	50.00		14:41	20	43.33	
	18:14	26	8.33		13:35	15	98.33		14:43	18	41.67	
		<b>26</b>	<b>17.311828</b>			<b>19.3225806</b>	<b>39.14</b>			<b>12.516129</b>	<b>40.16</b>	
07/09/2017			-	07/09/2017				07/09/2017			-	
	10:34	21	35.00		15:08	16	31.67		15:12	16	50.00	
	10:36	21	46.67		15:10	15	40.00		15:14	16	53.33	
	10:38	21	55.00		15:12	14	33.33		15:16	13	48.33	
	10:40	20	56.67		15:14	13	43.33		15:18	13	46.67	
	10:42	22	53.33		15:16	14	43.33		15:20	16	48.33	
	10:44	24	55.00		15:18	15	31.67		15:22	16	55.00	
	10:46	23	46.67		15:20	28	40.00		15:24	16	56.67	
	10:48	22	36.67		15:22	16	38.33		15:26	16	61.67	
	10:50	20	46.67		15:24	15	38.33		15:28	17	55.00	
	10:52	24	118.33		15:26	16	43.33		15:30	14	56.67	
	10:54	20	61.67		15:28	12	46.67		15:32	14	50.00	
	10:56	33	100.00		15:30	12	43.33		15:34	12	38.33	
	10:58	25	161.67		15:32	16	46.67		15:36	13	50.00	
	11:00	32	31.67		15:34	14	46.67		15:38	14	53.33	
	11:02	37	71.67		15:36	14	38.33		15:40	16	41.67	
	11:04	34	35.00		15:38	14	46.67		15:42	15	36.67	
	11:06	29	41.67		15:40	12	38.33		15:44	17	46.67	
	11:08	32	33.33		15:42	12	38.33		15:46	16	41.67	

	11:10	34	26.67		15:44	12	43.33		15:48	16	45.00	
	11:12	35	-		15:46	14	50.00		15:50	16	51.67	
	11:14	39	48.33		15:48	13	53.33		15:52	18	53.33	
	11:16	42	93.33		15:50	14	35.00		15:54	18	50.00	
	11:18	38	45.00		15:52	13	50.00		15:56	17	53.33	
	11:20	33	41.67		15:54	14	46.67		15:58	19	43.33	
	11:22	30	43.33		15:56	14	36.67		16:00	18	46.67	
	11:24	33	41.67		15:58	13	46.67		16:02	19	50.00	
	11:26	26	38.33		16:00	16	50.00		16:04	18	53.33	
	11:28	24	38.33		16:02	13	41.67		16:06	21	46.67	
	11:30	24	43.33		16:04	16	55.00		16:08	20	45.00	
	11:32	36	41.67		16:06	16	45.00		16:10	19	41.67	
	11:34	40	31.67		16:08	15	51.67		16:12	21	48.33	
		<b>28.8387097</b>	<b>52.2580645</b>			<b>14.5483871</b>	<b>43.01</b>			<b>16.4516129</b>	<b>48.98</b>	
08/09/2017			-	08/09/2017				08/09/2017			-	
	17:42	10	83.33		10:54	5	-		11:59	5	26.67	
	17:44	10	33.33		10:56	5	-		12:01	5	25.00	
	17:46	11	26.67		10:58	6	-		12:03	5	25.00	
	17:48	11	38.33		11:00	3	-		12:05	5	-	
	17:50	11	116.67		11:02	12	-		12:07	3	-	
	17:52	14	30.00		11:04	12	-		12:09	3	-	
	17:54	16	33.33		11:06	3	-		12:11	5	-	
	17:56	28	31.67		11:08	9	-		12:13	5	-	
	17:58	25	36.67		11:10	5	-		12:15	7	-	
	18:00	24	30.00		11:12	3	-		12:17	5	-	
	18:02	22	33.33		11:14	24	-		12:19	5	-	

	18:04	17	28.33		11:16	16	-		12:21	5	-	
	18:06	17	30.00		11:18	22	-		12:23	5	-	
	18:08	11	31.67		11:20	12	-		12:25	5	-	
	18:10	12	33.33		11:22	5	-		12:27	5	-	
	18:12	12	28.33		11:24	3	-		12:29	5	38.33	
	18:14	12	31.67		11:26	3	-		12:31	5	26.67	
	18:16	11	30.00		11:28	5	-		12:33	3	-	
	18:18	12	25.00		11:30	3	-		12:35	3	-	
	18:20	16	35.00		11:32	4	-		12:37	3	-	
	18:22	14	33.33		11:34	3	-		12:39	3	-	
	18:24	14	31.67		11:36	3	-		12:41	3	25.00	
	18:26	12	31.67		11:38	3	-		12:43	5	26.67	
	18:28	13	25.00		11:40	3	28.33		12:45	3	28.33	
	18:30	15	30.00		11:42	5	35.00		12:47	3	25.00	
	18:32	15	33.33		11:44	9	25.00		12:49	5	30.00	
	18:34	16	35.00		11:46	12	26.67		12:51	4	25.00	
	18:36	13	35.00		11:48	5	30.00		12:53	3	30.00	
	18:38	12	26.67		11:50	20	46.67		12:55	3	25.00	
	18:40	15	36.67		11:52	15	25.00		12:57	3	-	
	18:42	60	25.00		11:54	16	25.00		12:59	3	-	
		<b>16.1612903</b>	<b>35.8064516</b>			<b>8.19354839</b>	<b>7.80</b>			<b>4.19354839</b>	<b>11.51</b>	
09/09/2017			-	09/09/2017				09/09/2017			-	
	09:06	48	-		17:03	35	60.00		18:07	20	68.33	
	09:08	50	-		17:05	35	65.00		18:09	38	65.00	
	09:10	49	46.67		17:07	28	60.00		18:11	38	71.67	
	09:12	45	25.00		17:09	26	66.67		18:13	36	71.67	

	09:14	43	25.00		17:11	20	53.33		18:15	36	65.00	
	09:16	42	28.33		17:13	24	58.33		18:17	46	68.33	
	09:18	43	26.67		17:15	22	53.33		18:19	43	66.67	
	09:20	45	26.67		17:17	22	60.00		18:21	43	71.67	
	09:22	36	25.00		17:19	21	60.00		18:23	42	68.33	
	09:24	38	25.00		17:21	23	56.67		18:25	41	63.33	
	09:26	38	25.00		17:23	24	65.00		18:27	43	68.33	
	09:28	40	26.67		17:25	21	61.67		18:29	42	75.00	
	09:30	34	25.00		17:27	22	71.67		18:31	42	75.00	
	09:32	34	-		17:29	22	68.33		18:33	45	71.67	
	09:34	29	25.00		17:31	25	68.33		18:35	44	68.33	
	09:36	29	25.00		17:33	23	53.33		18:37	47	68.33	
	09:38	30	25.00		17:35	24	58.33		18:39	48	65.00	
	09:40	32	25.00		17:37	22	60.00		18:41	51	71.67	
	09:42	32	-		17:39	26	71.67		18:43	48	71.67	
	09:44	32	25.00		17:41	27	80.00		18:45	52	71.67	
	09:46	30	31.67		17:43	26	68.33		18:47	48	75.00	
	09:48	32	28.33		17:45	27	70.00		18:49	57	71.67	
	09:50	35	28.33		17:47	29	63.33		18:51	54	75.00	
	09:52	32	25.00		17:49	31	75.00		18:53	57	71.67	
	09:54	30	25.00		17:51	32	76.67		18:55	60	63.33	
	09:56	16	25.00		17:53	31	65.00		18:57	62	73.33	
	09:58	36	-		17:55	32	66.67		18:59	62	66.67	
	10:00	34	25.00		17:57	28	61.67		19:01	57	75.00	
	10:02	37	25.00		17:59	32	63.33		19:03	56	71.67	
	10:04	35	-		18:01	28	60.00		19:05	52	75.00	

	10:06	37	25.00		18:03	9	56.67		19:07	55	81.67	
		36.2258065	21.5591398			25.7096774	63.82			47.2580645	70.54	

#### Darou Thioubene

#### Keur Wally

#### Masseipe Mbengue

Date	TIME	PM10	NO2 µg/m3	Date	TIME	PM10	NO2 µg/m3	DATE	TIME	PM10 µg/m3	NO2 µg/m3	NO2 µg/m3
05/09/2017	10H47	5	-	05/09/2017	11H55	5	-	05/09/2017		10		-
	10H50	5	-		11H58	5	-			7		-
	10H53	5	-		12H01	8	-			10		-
	10H56	7	-		12H04	5	-			10		-
	10H59	7	-		12H07	5	-			10		-
	11H02	15	-		12H10	5	-			8		-
	11H05	9	-		12H13	5	-			10		-
	11H08	10	-		12H16	5	-			7		-
	11H11	9	-		12H19	5	-			8		-
	11H14	10	-		12H22	7	-			5		-
	11H17	8	-		12H25	5	-			10		-
	11H20	7	-		12H27	6	-			7		-
	11H23	6	-		12H30	5	-			9		-
	11H25	5	-		12H33	5	-			8		-
	11H28	5	-		12H36	5	-			7		-
	11H31	8	-		12H39	5	-			8		-
	11H34	7	-		12H42	5	-			8		-
	11H37	7	-		12H45	5	-			8		-
	11H40	5	-		12H48	5	-			8		-
	11H43	8	-		12H51	5	-			9		-

	11H46	5	-		12H55	5	-			9		-
		<b>7.28571429</b>	-			<b>5.28571429</b>	<b>0</b>			<b>8.38095238</b>	<b>#DIV/0!</b>	-
06/09/2017			-	06/09/2017			-	06/09/2017				-
	14:50	97	-		16:02	16	-		11:26	25	0	-
	14:52	31	-		16:04	20	-		11:28	22	0	-
	14:54	39	-		16:06	17	-		11:30	28	0	-
	14:56	30	25.00		16:08	18	675.00		11:32	86	0	-
	14:58	21	26.67		16:10	18	133.33		11:34	85	0	-
	15:00	28	28.33		16:12	17	201.67		11:36	88	0	-
	15:02	24	31.67		16:14	22	165.00		11:38	32	0	-
	15:04	24	31.67		16:16	21	-		11:40	13	0	-
	15:06	22	36.67		16:18	19	-		11:42	47	0	-
	15:08	22	35.00		16:20	20	-		11:44	24	0.23	38.33
	15:10	22	30.00		16:22	21	-		11:46	62	0.19	31.67
	15:12	25	35.00		16:24	19	-		11:48	62	0.21	35.00
	15:14	33	31.67		16:26	22	-		11:50	72	0.17	28.33
	15:16	35	33.33		16:28	19	-		11:52	33	0.15	25.00
	15:18	39	31.67		16:30	20	28.33		11:54	58	0.16	26.67
	15:20	31	30.00		16:32	22	-		11:56	70	0.17	28.33
	15:22	28	31.67		16:34	18	-		11:58	32	0.19	31.67
	15:24	35	33.33		16:36	18	-		12:00	32	0.19	31.67
	15:26	32	26.67		16:38	18	-		12:02	39	0.17	28.33
	15:28	49	25.00		16:40	17	-		12:04	64	0.15	25.00
	15:30	28	-		16:42	28	-		12:06	32	0.17	28.33
	15:32	28	-		16:44	18	-		12:08	37	0.15	25.00
	15:34	28	26.67		16:46	18	-		12:10	22	0.22	36.67

	15:36	25	28.33		16:48	19	-		12:12	40	0.16	26.67
	15:38	23	-		16:50	19	-		12:14	58	0.15	25.00
	15:40	22	-		16:52	17	-		12:16	33	0.19	31.67
	15:42	23	25.00		16:54	18	-		12:18	40	0.16	26.67
	15:44	21	-		16:56	17	-		12:20	44	0	-
	15:46	26	25.00		16:58	18	30.00		12:22	27	0	-
	15:48	25	25.00		17:00	26	28.33		12:24	44		-
	15:50	38	25.00		17:02	24	28.33		12:26	42		-
		<b>30.7741935</b>	<b>21.8817204</b>			<b>19.483871</b>	<b>41.6129032</b>			<b>44.9354839</b>	<b>0.01416667</b>	<b>17.10</b>
07/09/2017			-	07/09/2017			-	07/09/2017	09:24	18	0.19	31.67
	17:18	23	38.33		18:22	30	46.67		09:26	23	0.28	46.67
	17:20	24	41.67		18:24	31	53.33		09:28	22	0.32	53.33
	17:22	26	36.67		18:26	36	50.00		09:30	23	0.52	86.67
	17:24	26	45.00		18:28	36	53.33		09:32	23	0.30	50.00
	17:26	25	46.67		18:30	41	46.67		09:34	24	0.42	70.00
	17:28	27	50.00		18:32	38	50.00		09:36	23	0.39	65.00
	17:30	27	48.33		18:34	42	50.00		09:38	23	0.34	56.67
	17:32	26	51.67		18:36	42	51.67		09:40	245	0.36	60.00
	17:34	20	53.33		18:38	38	53.33		09:42	23	0.34	56.67
	17:36	22	51.67		18:40	34	60.00		09:44	23	0.35	58.33
	17:38	20	56.67		18:42	36	53.33		09:46	21	0.33	55.00
	17:40	23	53.33		18:44	31	66.67		09:48	22	0.35	58.33
	17:42	21	51.67		18:46	44	60.00		09:50	20	0.31	51.67
	17:44	24	51.67		18:48	43	46.67		09:52	21	0.30	50.00
	17:46	23	50.00		18:50	40	55.00		09:54	19	0.28	46.67
	17:48	23	50.00		18:52	39	51.67		09:56	18	0.37	61.67



	17:50	23	50.00		18:54	45	55.00		09:58	21	0.32	53.33
	17:52	23	50.00		18:56	41	55.00		10:00	19	0.39	65.00
	17:54	23	48.33		18:58	37	51.67		10:02	18	0.58	96.67
	17:56	24	50.00		19:00	44	53.33		10:04	18	0.25	41.67
	17:58	26	46.67		19:02	44	50.00		10:06	22	0.21	35.00
	18:00	26	48.33		19:04	47	56.67		10:08	17	0.28	46.67
	18:02	23	50.00		19:06	47	45.00		10:10	18	0.23	38.33
	18:04	22	50.00		19:08	41	46.67		10:12	20	0.25	41.67
	18:06	22	48.33		19:10	42	50.00		10:14	18	0.23	38.33
	18:08	22	51.67		19:12	42	45.00		10:16	18	0.24	40.00
	18:10	23	53.33		19:14	43	50.00		10:18	19	0.23	38.33
	18:12	23	46.67		19:16	45	50.00		10:20	17	0.26	43.33
	18:14	24	50.00		19:18	46	46.67		10:22	18	0.20	33.33
	18:16	25	53.33		19:20	47	51.67		10:24	18	0.17	28.33
	18:18	24	53.33		19:22	67	53.33			<b>36.3481823</b>	<b>0.01416667</b>	<b>34.05</b>
		<b>23.6451613</b>	<b>49.25</b>			<b>41.2580645</b>	<b>51.8817204</b>	08/09/2017				-
08/09/2017	09:51	5	-	08/09/2017			-		16:36	7	6.46	1 076.67
	09:53	3	-		08:47	0	46.67		16:38	9	0.18	30.00
	09:55	3	68.33		08:49	1	43.33		16:40	10	0.19	31.67
	09:57	3	-		08:51	1	43.33		16:42	9	0.19	31.67
	09:59	3	-		08:53	1	46.67		16:44	12	0.15	25.00
	10:01	3	-		08:55	1	46.67		16:46	11	0.18	30.00
	10:03	3	-		08:57	1	41.67		16:48	15	0.15	25.00
	10:05	3	-		08:59	1	38.33		16:50	12	0.21	35.00
	10:07	3	-		09:01	1	31.67		16:52	15	0.17	28.33
	10:09	3	-		09:03	1	35.00		16:54	9	0.15	25.00

	10:11	3	-		09:05	1	36.67		16:56	9	0.17	28.33
	10:13	5	-		09:07	2	38.33		16:58	10	0.2	33.33
	10:15	8	-		09:09	1	36.67		17:00	8	0.17	28.33
	10:17	8	-		09:11	5	28.33		17:02	10	0.15	25.00
	10:19	5	-		09:13	1	31.67		17:04	9	0.15	25.00
	10:21	3	-		09:15	1	38.33		17:06	10	0.17	28.33
	10:23	3	-		09:17	1	30.00		17:08	8	0.17	28.33
	10:25	5	-		09:19	1	35.00		17:10	10	0.16	26.67
	10:27	7	-		09:21	1	33.33		17:12	10	0.17	28.33
	10:29	3	-		09:23	1	33.33		17:14	10	0.19	31.67
	10:31	0	25.00		09:25	1	28.33		17:16	26	0.15	25.00
	10:33	1	-		09:27	3	33.33		17:18	34	0.15	25.00
	10:35	5	35.00		09:29	3	25.00		17:20	21	0.18	30.00
	10:37	3	-		09:31	3	28.33		17:22	13	0.17	28.33
	10:39	3	-		09:33	3	25.00		17:24	16	0.16	26.67
	10:41	3	-		09:35	5	35.00		17:26	15	0.15	25.00
	10:43	3	-		09:37	15	-		17:28	17	0.15	25.00
	10:45	5	25.00		09:39	14	28.33		17:30	22	0.16	26.67
	10:47	5	-		09:41	3	-		17:32	17	0.15	25.00
	10:49	5	-		09:43	0	-		17:34	22	0.18	30.00
	10:51	3	-		09:45	0	-		17:36	17	0.15	25.00
		13.8832565	27.45		09:47	0	-			13.6451613	#DIV/0!	61.72
09/09/2017			-			2.35483871	29.6236559	09/09/2017				-
	13:39	34	35.00	09/09/2017			-		15:54	20	0.36	60.00
	13:41	37	45.00		14:45	33	61.67		15:56	31	0.32	53.33
	13:43	35	55.00		14:47	42	61.67		15:58	31	0.34	56.67

	13:45	37	66.67		14:49	60	60.00		16:00	29	0.32	53.33
	13:47	34	68.33		14:51	36	61.67		16:02	31	0.36	60.00
	13:49	35	73.33		14:53	34	66.67		16:04	28	0.34	56.67
	13:51	37	71.67		14:55	32	60.00		16:06	29	0.36	60.00
	13:53	33	71.67		14:57	33	65.00		16:08	28	0.34	56.67
	13:55	40	78.33		14:59	36	66.67		16:10	29	0.35	58.33
	13:57	31	66.67		15:01	42	65.00		16:12	28	0.4	66.67
	13:59	38	70.00		15:03	30	55.00		16:14	32	0.36	60.00
	14:01	37	71.67		15:05	31	110.00		16:16	31	0.36	60.00
	14:03	34	75.00		15:07	37	66.67		16:18	34	0.34	56.67
	14:05	34	71.67		15:09	32	56.67		16:20	33	0.27	45.00
	14:07	36	71.67		15:11	33	68.33		16:22	45	0.29	48.33
	14:09	32	68.33		15:13	35	65.00		16:24	28	0.31	51.67
	14:11	34	71.67		15:15	30	55.00		16:26	29	0.33	55.00
	14:13	38	66.67		15:17	42	60.00		16:28	31	0.39	65.00
	14:15	38	68.33		15:19	57	60.00		16:30	28	0.36	60.00
	14:17	39	71.67		15:21	40	60.00		16:32	31	0.39	65.00
	14:19	40	68.33		15:23	33	60.00		16:34	32	0.43	71.67
	14:21	36	78.33		15:25	40	63.33		16:36	30	0.41	68.33
	14:23	38	63.33		15:27	33	75.00		16:38	35	0.4	66.67
	14:25	41	58.33		15:29	48	56.67		16:40	29	0.39	65.00
	14:27	32	65.00		15:31	32	63.33		16:42	28	0.36	60.00
	14:29	32	66.67		15:33	34	65.00		16:44	27	0.39	65.00
	14:31	36	65.00		15:35	29	58.33		16:46	27	0.35	58.33
	14:33	32	65.00		15:37	26	53.33		16:48	26	0.45	75.00
	14:35	30	65.00		15:39	24	50.00		16:50	24	0.36	60.00

	14:37	31	68.33		15:41	26	50.00		16:52	22	0.38	63.33
	14:39	33	68.33		15:43	26	58.33		16:54	25	0.37	61.67
		<b>35.2903226</b>	<b>66.77</b>		15:45	28	51.67			<b>29.3870968</b>	<b>0.39</b>	<b>60.11</b>
						<b>35.2903226</b>	<b>62.2580645</b>					

NGOUKHOUDJ				Malicounda Bambara				DRILLING / MALICOUNDA HEALTH DISTRICT			
DATE	TIME	PM10 µg/m3	NO2 µg/m3	DATE	TIME	PM10 µg/m3	NO2 µg/m3	DATE	TIME	PM10 µg/m3	NO2 µg/m3
05/09/2017	15H43	9	-	05/09/2017	17H00	13	-	05/09/2017	18H13	16	-
	15H46	10	-		17H03	11	-		18H16	13	-
	15H49	10	-		17H06	11	-		18H19	13	-
	15H52	10	-		17H09	12	-		18H22	13	-
	15H55	10	-		17H12	15	-		18H25	16	-
	15H58	9	-		17H15	12	-		18H28	105	-
	16H01	9	-		17H18	14	-		18H31	30	-
	16H04	10	-		17H21	14	-		18H34	81	-
	16H07	10	-		17H24	14	-		18H37	14	-
	16H10	10	-		17H27	13	-		18H40	15	-
	16H13	9	-		17H30	13	-		18H43	12	-
	16H16	10	-		17H33	13	-		18H46	13	-
	16H19	10	-		17H36	12	-		18H49	23	-
	16H22	10	-		17H39	14	-		18H52	106	-
	16H25	10	-		17H42	14	-		18H55	175	-
	16H28	10	-		17H45	12	-		18H58	110	-
	16H31	10	-		17H48	11	-		19H01	108	-
	16H34	9	-		17H51	25	-		19H04	126	-

	16H37	10	-		17H54	15	-		19H07	136	-
	16H40	9	-		17H57	20	-		19H10	54	-
	16H43	10	-		18H00	13	-		19H13	33	-
		<b>9.71428571</b>	-			<b>13.8571429</b>	<b>0</b>			<b>57.7142857</b>	-
06/09/2017				06/09/2017			-	06/09/2017			-
	7H46	33	-		10:15	14	-		09:03	21	-
	7H49	34	-		10:17	15	-		09:05	23	-
	7H52	33	-		10:19	11	28.33		09:07	20	-
	7H55	32	-		10:21	12	31.67		09:09	29	-
	7H58	34	-		10:23	12	36.67		09:11	35	-
	8H01	38	-		10:25	12	43.33		09:13	20	-
	8H04	41	-		10:27	11	46.67		09:15	21	-
	8H07	39	-		10:29	21	46.67		09:17	21	-
	8H10	42	-		10:31	13	46.67		09:19	19	-
	8H13	43	-		10:33	12	43.33		09:21	20	-
	8H	43	-		10:35	11	43.33		09:23	15	-
	8H22	38	-		10:37	12	40.00		09:25	24	30.00
	8H25	38	-		10:39	12	43.33		09:27	20	25.00
	8H28	36	-		10:41	12	40.00		09:29	20	26.67
	8H31	38	-		10:43	10	48.33		09:31	17	31.67
	8H34	34	-		10:45	12	43.33		09:33	16	25.00
	8H37	31	28.33		10:47	17	40.00		09:35	17	31.67
	8H40	32	160.00		10:49	16	36.67		09:37	15	31.67
	8H43	29	25.00		10:51	12	38.33		09:39	16	28.33
	8H46	30	-		10:53	10	31.67		09:41	17	25.00
		<b>35.9</b>	<b>10.67</b>		10:55	10	25.00		09:43	17	25.00

07/09/2017			-		10:57	10	25.00		09:45	17	30.00
	12:48	23	-		10:59	10	25.00		09:47	16	28.33
	12:50	29	31.67		11:01	10	28.33		09:49	22	25.00
	12:52	21	35.00		11:03	9	31.67		09:51	15	33.33
	12:54	29	46.67		11:05	11	30.00		09:53	16	38.33
	12:56	24	46.67		11:07	12	25.00		09:55	14	41.67
	12:58	38	43.33		11:09	12	25.00		09:57	23	28.33
	13:00	34	45.00		11:11	9	45.00		09:59	14	30.00
	13:02	26	53.33		11:13	10	48.33		10:01	15	30.00
	13:04	26	65.00		11:15	11	-		10:03	12	31.67
	13:06	39	51.67			11.9677419	33.4408602			18.9354839	19.25
	13:08	43	48.33	06/09/2017			-	07/09/2017			-
	13:10	46	55.00		19:32	47	28.33		14:00	20	28.33
	13:12	48	50.00		19:34	51	28.33		14:02	20	38.33
	13:14	56	48.33		19:36	49	30.00		14:04	23	31.67
	13:16	45	46.67		19:38	47	31.67		14:06	20	38.33
	13:18	39	46.67		19:40	47	83.33		14:08	18	53.33
	13:20	67	50.00		19:42	54	138.33		14:10	20	50.00
	13:22	53	45.00		19:44	53	210.00		14:12	18	48.33
	13:24	33	50.00		19:46	51	88.33		14:14	21	55.00
	13:26	33	38.33		19:48	52	70.00		14:16	30	50.00
	13:28	45	46.67		19:50	51	51.67		14:18	21	55.00
	13:30	34	43.33		19:52	51	36.67		14:20	20	53.33
	13:32	36	48.33		19:54	48	40.00		14:22	18	73.33
	13:34	39	48.33		19:56	46	51.67		14:24	18	90.00
	13:36	27	43.33		19:58	46	35.00		14:26	17	86.67

	13:38	25	53.33		20:00	47	28.33		14:28	15	53.33
	13:40	27	46.67		20:02	45	30.00		14:30	18	55.00
	13:42	29	41.67		20:04	49	31.67		14:32	18	50.00
	13:44	38	40.00		20:06	46	30.00		14:34	17	46.67
	13:46	49	56.67		20:08	44	30.00		14:36	18	51.67
		36.7	45.50		20:10	40	31.67		14:38	17	33.33
08/09/2017			-		20:12	43	33.33		14:40	17	48.33
	18:50	16	38.33		20:14	43	35.00		14:42	23	46.67
	18:52	10	26.67		20:16	43	28.33		14:44	18	48.33
	18:54	16	28.33		20:18	41	30.00		14:46	19	53.33
	18:56	14	38.33		20:20	39	35.00		14:48	24	46.67
	18:58	12	16.67		20:22	41	31.67		14:50	16	50.00
	19:00	11	38.33		20:24	86	30.00		14:52	19	45.00
	19:02	11	41.67		20:26	52	26.67		14:54	15	53.33
	19:04	12	38.33		20:28	54	33.33		14:56	15	53.33
	19:06	20	38.33		20:30	49	40.00		14:58	15	50.00
	19:08	23	35.00		20:32	46	25.00		15:00	14	51.67
	19:10	16	41.67			48.4193548	46.8817204			18.7741935	51.24
	19:12	14	38.33	08/09/2017			-	08/09/2017			-
	19:14	14	38.33		15:26	6	26.67		13:10	18	-
	19:16	14	46.67		15:28	10	30.00		13:12	18	-
	19:18	14	45.00		15:30	7	28.33		13:14	23	-
	19:20	15	40.00		15:32	8	25.00		13:16	11	-
	19:22	14	38.33		15:34	9	-		13:18	34	-
	19:24	15	50.00		15:36	8	25.00		13:20	22	-
	19:26	12	143.33		15:38	7	-		13:22	41	-

	19:28	11	40.00		15:40	7	-		13:24	39	-
	19:30	13	43.33		15:42	7	-		13:26	24	-
	19:32	15	43.33		15:44	8	28.33		13:28	80	-
	19:34	15	46.67		15:46	8	25.00		13:30	54	-
	19:36	14	53.33		15:48	7	25.00		13:32	10	-
	19:38	36	46.67		15:50	8	31.67		13:34	12	-
	19:40	36	43.33		15:52	12	30.00		13:36	31	-
	19:42	49	38.33		15:54	8	28.33		13:38	24	-
	19:44	76	41.67		15:56	7	26.67		13:40	26	-
	19:46	84	36.67		15:58	8	25.00		13:42	37	-
	19:48	59	33.33		16:00	7	25.00		13:44	35	-
	19:50	147	31.67		16:02	8	-		13:46	36	-
		<b>26.7096774</b>	<b>42.58</b>		16:04	7	-		13:48	18	-
09/09/2017			-		16:06	8	25.00		13:50	16	-
	10:14	38	-		16:08	7	-		13:52	11	-
	10:16	39	-		16:10	8	-		13:54	16	-
	10:18	36	25.00		16:12	7	-		13:56	16	-
	10:20	40	31.67		16:14	8	133.33		13:58	12	-
	10:22	39	41.67		16:16	7	130.00		14:00	16	-
	10:24	41	33.33		16:18	8	25.00		14:02	16	-
	10:26	40	31.67		16:20	7	83.33		14:04	12	25.00
	10:28	40	25.00		16:22	8	30.00		14:06	7	-
	10:30	38	25.00		16:24	8	35.00		14:08	12	-
	10:32	44	41.67		16:26	7	25.00		14:10	32	25.00
	10:34	40	28.33			<b>7.74193548</b>	<b>27.9569892</b>			<b>24.483871</b>	<b>1.61</b>
	10:36	40	28.33	09/09/2017			-	09/09/2017			-



	10:38	44	35.00		12:30	37	-		11:25	46	-
	10:40	38	36.67		12:32	31	-		11:27	36	-
	10:42	40	28.33		12:34	31	-		11:29	38	25.00
	10:44	40	31.67		12:36	32	71.67		11:31	35	30.00
	10:46	40	-		12:38	32	75.00		11:33	32	31.67
	10:48	37	30.00		12:40	33	60.00		11:35	34	26.67
	10:50	39	35.00		12:42	30	53.33		11:37	31	28.33
	10:52	41	25.00		12:44	29	56.67		11:39	33	25.00
	10:54	41	-		12:46	25	53.33		11:41	36	25.00
	10:56	39	-		12:48	17	46.67		11:43	32	28.33
	10:58	46	-		12:50	18	28.33		11:45	31	33.33
	11:00	43	25.00		12:52	33	38.33		11:47	31	30.00
	11:02	44	-		12:54	36	35.00		11:49	31	38.33
	11:04	43	-		12:56	34	50.00		11:51	35	25.00
	11:06	42	26.67		12:58	40	51.67		11:53	28	33.33
	11:08	43	-		13:00	37	58.33		11:55	27	-
	11:10	39	-		13:02	35	68.33		11:57	29	-
	11:12	39	-		13:04	30	70.00		11:59	30	-
	11:14	39	-		13:06	30	66.67		12:01	35	26.67
		<b>40.3870968</b>	<b>18.87</b>		13:08	31	71.67		12:03	27	-
					13:10	29	68.33		12:05	27	25.00
					13:12	32	78.33		12:07	25	25.00
					13:14	27	75.00		12:09	25	25.00
					13:16	28	66.67		12:11	29	-
					13:18	27	68.33		12:13	25	-
					13:20	27	71.67		12:15	26	-

					13:22	25	60.00		12:17	27	31.67
					13:24	28	65.00		12:19	27	25.00
					13:26	29	60.00		12:21	30	-
					13:28	30	71.67		12:23	26	-
					13:30	26	75.00		12:25	25	-
						<b>29.9677419</b>	<b>55.3225806</b>			<b>30.6129032</b>	<b>17.37</b>

MALICOUNDA ELECTRICAL STATION			
DATE	TIME	PM10 µg/m3	NO2 µg/m3
06/09/2017	18:22	21	181.67
	18:24	21	171.67
	18:26	19	163.33
	18:28	17	153.33
	18:30	18	135.00
	18:32	18	118.33
	18:34	18	108.33
	18:36	18	101.67
	18:38	21	90.00
	18:40	22	86.67
	18:42	21	78.33
	18:44	22	76.67
	18:46	21	80.00
	18:48	19	70.00
	18:50	19	70.00
	18:52	18	68.33
	18:54	18	63.33
	18:56	17	66.67
	18:58	17	56.67
	19:00	19	53.33
	19:02	17	51.67
	19:04	18	45.00
	19:06	18	48.33
	19:08	19	50.00
	19:10	19	50.00
	19:12	18	51.67
	19:14	18	50.00
	19:16	18	46.67
	19:18	18	46.67
	19:20	17	46.67
	19:22	19	48.33
		<b>18.8064516</b>	<b>81.56</b>
07/09/2017			-
	11:40	16	43.33
	11:42	13	31.67
	11:44	14	50.00
	11:46	13	38.33
	11:48	14	33.33
	11:50	15	41.67

	11:52	13	33.33
	11:54	14	40.00
	11:56	14	46.67
	11:58	12	35.00
	12:00	11	43.33
	12:02	12	33.33
	12:04	12	43.33
	12:06	12	35.00
	12:08	12	41.67
	12:10	9	38.33
	12:12	12	30.00
	12:14	11	56.67
	12:16	12	36.67
	12:18	12	35.00
	12:20	11	40.00
	12:22	12	28.33
	12:24	12	28.33
	12:26	12	35.00
	12:28	14	33.33
	12:30	12	33.33
	12:32	14	31.67
	12:34	14	43.33
	12:36	12	33.33
	12:38	12	38.33
	12:40	11	35.00
		<b>12.5483871</b>	<b>37.63</b>
08/09/2017			-
	14:18	0	31.67
	14:20	0	35.00
	14:22	9	40.00
	14:24	8	28.33
	14:26	8	28.33
	14:28	8	48.33
	14:30	8	31.67
	14:32	8	25.00
	14:34	7	28.33
	14:36	9	26.67
	14:38	9	28.33
	14:40	10	33.33
	14:42	12	38.33
	14:44	10	35.00
	14:46	7	26.67

	14:48	8	31.67
	14:50	7	28.33
	14:52	7	31.67
	14:54	8	33.33
	14:56	7	30.00
	14:58	7	30.00
	15:00	5	30.00
	15:02	7	31.67
	15:04	7	35.00
	15:06	8	31.67
	15:08	10	38.33
	15:10	9	26.67
	15:12	8	38.33
	15:14	8	33.33
	15:16	8	33.33
	15:18	7	33.33
		<b>7.5483871</b>	<b>32.31</b>
09/09/2017			-
	08:02	33	51.67
	08:04	67	50.00
	08:06	58	53.33
	08:08	62	51.67
	08:10	64	56.67
	08:12	63	51.67
	08:14	63	50.00
	08:16	66	51.67
	08:18	62	50.00
	08:20	61	51.67
	08:22	65	38.33
	08:24	66	46.67
	08:26	74	36.67
	08:28	72	33.33
	08:30	69	36.67
	08:32	63	38.33
	08:34	67	33.33
	08:36	72	28.33
	08:38	64	31.67
	08:40	64	31.67
	08:42	62	25.00
	08:44	67	25.00
	08:46	61	28.33
	08:48	57	28.33
	08:50	60	28.33
	08:52	57	28.33
	08:54	59	28.33
	08:56	62	28.33
	08:58	57	28.33
	09:00	58	25.00
	09:02	60	31.67
		<b>62.4193548</b>	<b>38.01</b>

Time	Gas type	Concentration		Unit	Span		
2017_09_05 09:27:31	SO2	0.37	370	mg/m <sup>3</sup>	20	98.9041096	Keur Maissa faye
2017_09_05 10:35:33	SO2	0	0	mg/m <sup>3</sup>	20	80.4615385	Malicounda Solar station
2017_09_05 11:47:47	SO2	0	0	mg/m <sup>3</sup>	20	6.02941176	Darou Thioubene
2017_09_05 12:55:29	SO2	0.03	30	mg/m <sup>3</sup>	20	30	Keur Wally
2017_09_05 14:12:14	SO2	0	0	mg/m <sup>3</sup>	20	35.8208955	Malicounda Nguerigne
2017_09_05 15:25:21	SO2	0	0	mg/m <sup>3</sup>	20	56.4179104	Masseipe Mbengue
2017_09_05 16:43:00	SO2	0.06	60	mg/m <sup>3</sup>	20	65.6716418	NGOUKHOUDJ
2017_09_05 18:00:39	SO2	0.05	50	mg/m <sup>3</sup>	20	48.6764706	Malicounda Bambara
2017_09_05 19:12:12	SO2	0	0	mg/m <sup>3</sup>	20	32.8070175	drilling/ Malicounda Health district

Time	Gas type	Concentration		Unit	Span			
2017_09_06 08:46:14	SO2	0	0	mg/m <sup>3</sup>	20	5.16666667	NGOUKHOUDJ	5.16666667 NGOUKHOUDJ
2017_09_06 10:05:47	SO2	0.09	90	mg/m <sup>3</sup>	20	69.4117647	Drilling health district	69.4117647 Drilling health district
2017_09_06 11:15:18	SO2	0.11	110	mg/m <sup>3</sup>	20	100	Malicounda Bambara	100 Malicounda Bambara
2017_09_06 12:26:38	SO2	0.13	130	mg/m <sup>3</sup>	20	134.852941	Masseipe Mbengue	134.852941 Masseipe Mbengue
2017_09_06 13:35:15	SO2	0.13	130	mg/m <sup>3</sup>	20	122.089552	Keur maissa faye	122.089552 Keur maissa faye
2017_09_06 14:43:52	SO2	0.1	100	mg/m <sup>3</sup>	20	109.558824	Malicounada solar station	109.558824 Malicounada solar station
2017_09_06 15:50:40	SO2	0.09	90	mg/m <sup>3</sup>	20	98.5294118	Darou Thioubene	98.5294118 Darou Thioubene
2017_09_06 17:02:54	SO2	0.09	90	mg/m <sup>3</sup>	20	89.2647059	Keur Wally	89.2647059 Keur Wally
2017_09_06 18:14:54	SO2	0.05	50	mg/m <sup>3</sup>	20	72.6153846	Malicounda Nguerigne	72.6153846 Malicounda Nguerigne
2017_09_06 19:23:02	SO2	0.07	70	mg/m <sup>3</sup>	20	68.030303	Electrical station	68.030303 Electrical station

Time	Gas type	Concentration		Unit	Span		
2017_09_07 10:32:49	SO2	0.13	130	mg/m <sup>3</sup>	20	165	Malicounda Bambara
2017_09_07 11:34:12	SO2	0.09	90	mg/m <sup>3</sup>	20	111.940299	Malicounda Nguerigne
2017_09_07 12:40:06	SO2	0.14	140	mg/m <sup>3</sup>	20	118.507463	Malicounda electrical station
2017_09_07 13:48:43	SO2	0.1	100	mg/m <sup>3</sup>	20	115.882353	NGOUKHOUDJ
2017_09_07 15:00:57	SO2	0.09	90	mg/m <sup>3</sup>	20	94.1176471	Drilling health district
2017_09_07 16:08:36	SO2	0.07	70	mg/m <sup>3</sup>	20	91.2121212	Keur Maissa Faye

2017_09_07 17:12:18	SO2	0.08	80	mg/m 3	20	84.838709 7	Solar station
2017_09_07 18:18:12	SO2	0.07	70	mg/m 3	20	84.307692 3	Darou Thioubene
2017_09_07 19:22:52	SO2	0.08	80	mg/m 3	20	71.5625	Keur Wally
2017_09_07 20:32:36	SO2	0.05	50	mg/m 3	20	64.262295 1	Malicounda Bambara

Time	Gas type	Concentration		Unit	Span		
2017_09_08 09:47:11	SO2	0.05	50	mg/m3	20	42.7536232	Keur wally
2017_09_08 10:51:16	SO2	0.05	50	mg/m3	20	47.0149254	Darou Thioubene
2017_09_08 11:54:28	SO2	0.05	50	mg/m3	20	43.5820896	Keur maissa faye
2017_09_08 12:59:27	SO2	0.06	60	mg/m3	20	51.7910448	Solar station
2017_09_08 14:10:46	SO2	0.06	60	mg/m3	20	62.6470588	Drilling/ health district
2017_09_08 15:18:28	SO2	0.06	60	mg/m3	20	69.7014925	Electrical station
2017_09_08 16:26:11	SO2	0.1	100	mg/m3	20	87.0149254	Malicounca Bambara
2017_09_08 17:36:35	SO2	0.07	70	mg/m3	20	86.7647059	Masseipe Mbengue
2017_09_08 18:59:55	SO2	0.06	60	mg/m3	20	52.2222222	Malicounda nguerigne
2017_09_08 19:50:19	SO2	0.05	50	mg/m3	20	72.5641026	NGOUKHOUDJ

Time	Gas type	Concentration		Unit	Span		
2017_09_09 09:02:05	SO2	0.05	50	mg/m3	20	35.3846154	Electrical station
2017_09_09 10:06:11	SO2	0.07	70	mg/m3	20	68.9552239	Malicounda Nguerigne
2017_09_09 11:16:37	SO2	0.09	90	mg/m3	20	88.5294118	NGOUKHOUDJ
2017_09_09 12:25:14	SO2	0.12	120	mg/m3	20	98.5074627	Drilling health district
2017_09_09 13:30:14	SO2	0.12	120	mg/m3	20	118.955224	M bambara
2017_09_09 14:39:45	SO2	0.09	90	mg/m3	20	107.352941	Darou Thioubene
2017_09_09 15:45:40	SO2	0.09	90	mg/m3	20	87.6470588	Keur Wally
2017_09_09 16:54:17	SO2	0.07	70	mg/m3	20	85.6716418	Masseipe Mbengue
2017_09_09 17:59:17	SO2	0.09	90	mg/m3	20	81.6666667	Keur Maissa faye
2017_09_09 19:07:41	SO2	0.07	70	mg/m3	20	66.4516129	Solar station

## **APPENDIX 5.2: Geophysical study of drilling location**



REPUBLIC OF SENEGAL  
PROJECT OF CONDUCTING A PRODUCTIVE DRILLING WITH FRESHWATER IN THE  
**AREA OF MALICOUNDA POWER STATION**  
Thiès region, department of Mbour, municipality of Malicounda  
**MALICOUNDA POWER**

**GEOPHYSICAL PROSPECTION BY THE ELECTRICAL SURVEY METHOD FOR THE  
SEARCH OF AQUIFERATED LEVELS FAVORABLE TO THE CARRYING OUT OF A  
DRILLING PRODUCTIVE FRESHWATER**

REPORT  
DECEMBER 2017

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## INTRODUCTION

At the request of **MALICOUNDA POWER**, a geophysical prospecting by the electric sounding method is carried out in the area of the power station located in the village of Malicounda (municipality of Malicounda, department of Mbour, region Thiès, Republic of Senegal) (Figure 1).

Malicounda sector belongs to the coastal domain (small coast of Senegal). Consequently, the underground aquifers in the coastal domain are, generally, under the permanent influence of pollution by salt water from the salty bevel of the sea.

Two main objectives are targeted by this geophysical study:

- determine the detailed geoelectric resistivity of the underground layers from 0 to 40 meters deep for the installation of earth connections,
- locate a freshwater aquifer favorable to the realization of a productive drilling that can ensure the supply of water to the power station.

And give, in the favorable case, the estimated technical characteristics of the drilling to be carried out (total depth, length of the pumping chamber, level of the strainers, top of the gravel, etc.)

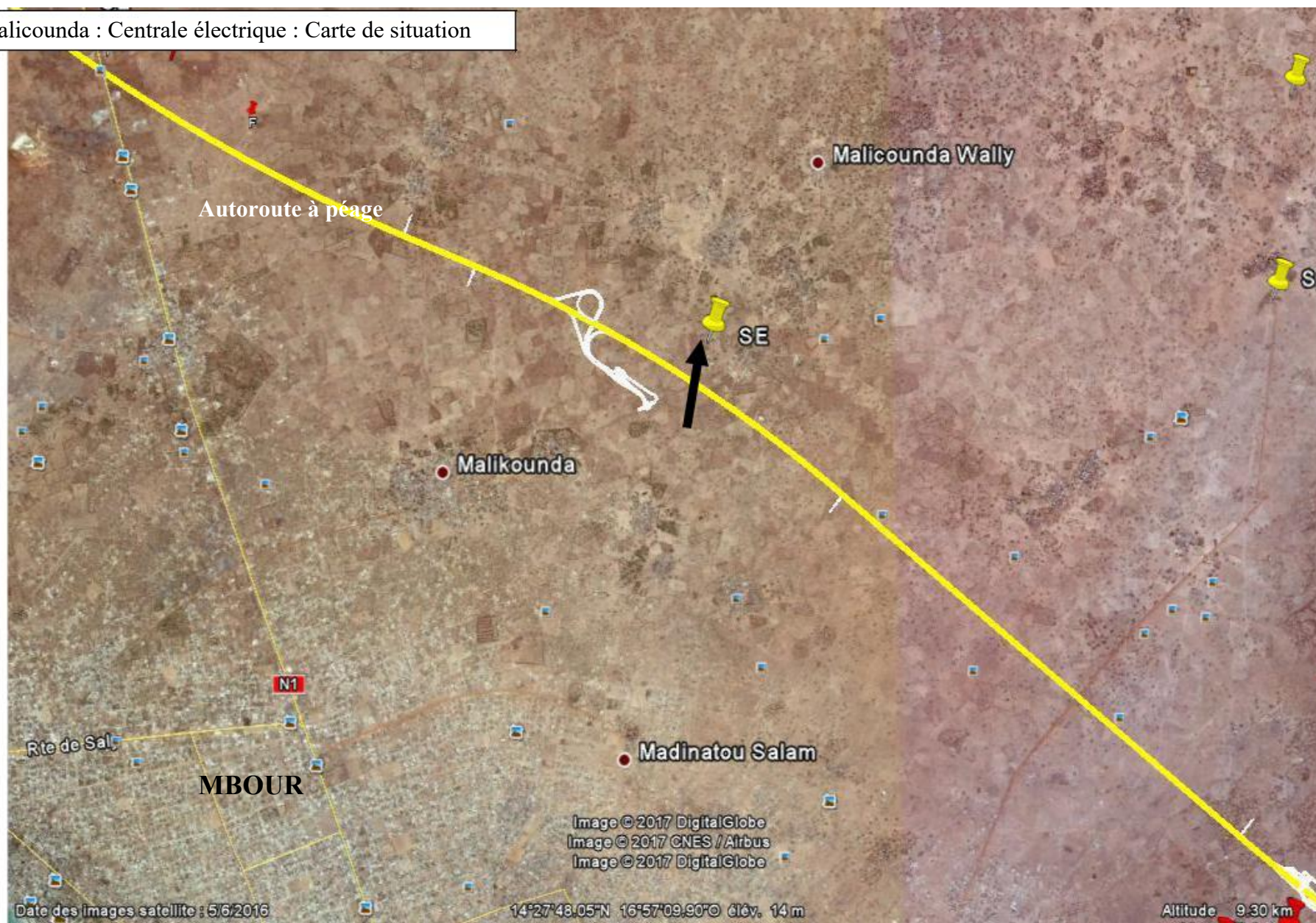
The study took place in two phases and is carried out by Dr Same DIOUF, Hydrogeologist-Geophysicist;

- **First phase:**
  - field survey carried out on December 26, 2017. This geophysical survey is preceded by a bibliographic investigation.
- **Second phase:**
  - The processing of field data, their hydrogeological interpretation and the writing of the report, from December 27 to 31, 2017.

The report includes:

- a power plant location map;
- a location map of the electrical survey carried out;
- information related to the study area hydrogeology;
- the results, their hydrogeological interpretation;
- The conclusion and recommendations;
- the electrical sounding curve (annex).

Fig 1 : Malicounda : Centrale électrique : Carte de situation



## I - BIBLIOGRAPHIC STUDY

### I.1 - Hydrogeological context

This study area is characterized by:

- The groundwater in the clay sands with lateritic clays of the **Continental Terminal** located at low depth.

The water in this low productivity fresh groundwater is polluted in places by salty sea invasions.

This groundwater is recharged by the annual rains. However, the level of this aquifer decline significantly at the end of the dry season.

- The Paleocene aquifer consists essentially of calcareous, marls and marly calcareous, is in hydraulic continuity, in its upper part, with the aquifer of the Continental Terminal in this sector.

Consequently, the calcareous aquifer of the Paleocene is in turn contaminated by the salt water of the sea.

The aquifer of the Maastrichtian clay sands underlies the brackish Paleocene aquifer.

The increase in the clay content in the sands of the Maastrichtian contributes to significantly reducing the flow of this aquifer.

### Conclusion

The geophysical study carried out in this area will allow us to identify the different aquifers in order to determine the estimated technical characteristics of the productive freshwater drilling to be carried out.

## **II - GEOPHYSICAL PROSPECTION CAMPAIGN BY THE ELECTRICAL SURVEY METHOD**

### **2.1 - Material and method**

#### **2.1.1 - Equipment**

The instrumentation consists of the following elements:

- 01 TERRAMETER SAS 300 C resistivity meter
- 01 TERRAMETER or BOOSTER SAS 2000 booster
- 04 12V Ni-Cd accumulators
- 04 rolls of AB injection cables of 500 m each
- 02 rolls of MN receiving cables of 50 m each
- 01 UBC Universal Battery charger
- 01 multimeter
- 01 solar panel for recharging the batteries
- 14 stainless steel electrodes
- 04 masses of 4 Kg
- 03 30 liter cans for watering
- Cement for the realization of the terminals of the electric soundings
- Water is systematically to sprinkle the soil-electrode contacts in order to reduce the setting resistances,
- A computer to carry out the first computer processing of the electrical soundings.  
It also enabled geoelectric cross-sections and the drafting of the report.
- A 4x4 all-terrain vehicle for transporting research personnel and equipment

The prospecting staff is made up of:

- - Doctor hydrogeologist-geophysicist
  - 8 maneuvers including a team leader
  - 1 driver

#### **2.1.2 - Geophysical prospecting method**

##### **A - General considerations**

The use of geophysical prospecting methods in hydrogeology makes it possible to determine parameters essential to the location and characterization of aquifers.

## B - Electrical methods

### B.1 - Principle of the geoelectric method

The resistivity of soils and rocks depends mainly on three factors:

- 1- The water content and resistivity (very variable),
- 2- Clay or marl content (low resistivity),
- 3- The matrix of the rock outside of the clay which is generally infinitely resistant.

If we disregard the presence of clay, a geological formation will be more resistant as it will have a low water content (massive limestones, healthy shales, non-clay formations outside the water table ...) or as the water will contain little mineralization.

On the other hand, when the clay or marl content becomes high in a formation, the resistivity of this formation becomes low.

This is how, depending on the geological context, we can, from the resistivity values, appreciate the nature and mechanical state (fracturing, alteration) of the geological formations.

The electrical methods used are electrical surveys, Schlumberger device.

### B.2 - The electrical survey

The electric current (a few tens of milliamps) is injected into the ground by a circuit (A, B) and the potential difference created at this current is measured between two electrodes M and N

An electrical survey therefore, consists in establishing the variation curve of the apparent resistivity of the land measured at the surface, as a function of the depth, using a AMNB quadrupole.

The depth of investigation increases as the distance between the injection electrodes A and B increases.

The figure below illustrates the distribution of the electric field.

The device chosen is of the Schlumberger type, that is to say the AB / MN ratio is kept as large as possible ( $4 < AB / MN < 20$ ). In this case the apparent resistivity  $R_o$  is expressed by the formula:

$$R_o = K.V/I \quad \text{ohm.m}$$

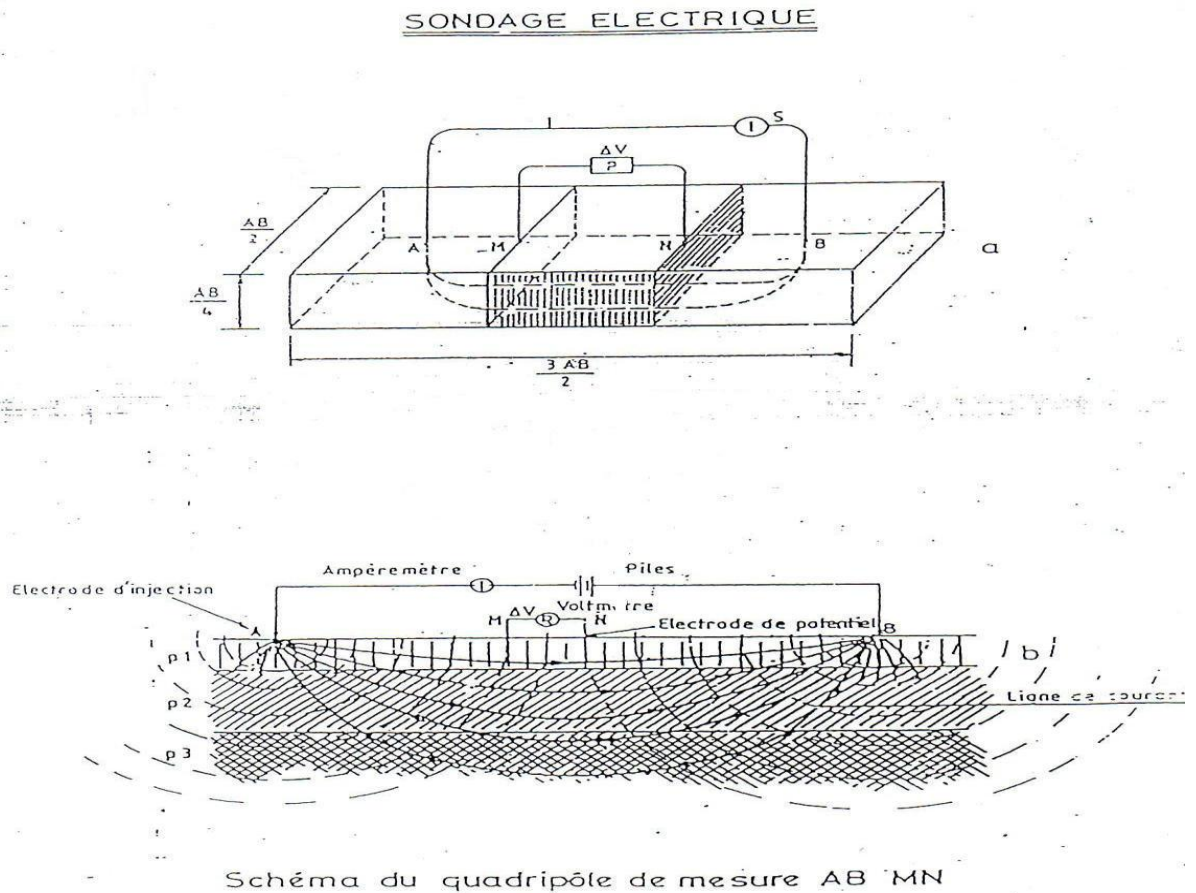
V : the ddp between M et N

I : the intensity of the direct current injected



**K**: the geometric coefficient, depends on the dimensions of the measuring device  $\pi(K = \times AM \times AN / MN)$ .

The depth of investigation is between  $AB / 4$  and  $AB / 12$ .



The interpretation of the electrical soundings makes it possible to obtain the true resistivity of the formations as well as their thicknesses, in the ideal case of homogeneous layers of low dip ( $<12^\circ$ ).

An inversion program will initially be used to release a starting model which will be improved with the PISE4 electrical sounding interpretation program developed by ORSTOM in Paris, C.N.R.S -France.

The resistivity of saturated rocks with electrolytic conductivity is a decreasing function:

- total communicating porosity;
- of the conductivity of the imbibition water



### **B.3 - Limitations of the method**

The main obstacle to the interpretation of an electrical survey is that a curved terrain can be fulfilled by several models. This is mainly related to the principles of equivalence and deletion.

#### ***- The principle of equivalence***

Within certain limits, the sounding curve does not depend only on the resistivity of a ground or its thickness separately, but on their product (transverse resistivity) or their quotient (longitudinal conductance).

#### ***- The principle of deletion***

It concerns the deep and/or thin layers whose resistivity is intermediate or close to the host lands. These layers only affect very slightly the curve.

But in the case of a geophysical study in a sedimentary site, the approximate knowledge of the nature of the various layers allows the objective determination of the geoelectric characteristics ( $\rho_l$ ), knowing the thickness (e).

It is therefore necessary to raise with the greatest care the geological problem, to see according to each case, if it is soluble by the method of electrical probes.

## **2.2 - RESULTS AND INTERPRETATION**

### **2.2.1 - Geophysical work carried out (Figure 2):**

01 SE deep electrical survey is carried out in the field with an AB electric injection line length of 1200 meters The geographic coordinates of the survey are:

Longitude : 16°56'59,0"

Latitude : 14°28'8,9"

### **2.2.2 - Hydrogeological results and interpretations of electrical soundings**

#### **2.2.2.1 - Determination of the geoelectric resistivity of the different layers between 0 and 40 meters deep for the installation of earth connections**

In this case the surface levels are targeted and detailed.

The detailed interpretation of the geoelectric resistivity of the first 40 meters allows us to establish the geoelectric log of Figure 3.

**2.2.2.2 - location of a freshwater aquifer favorable to carrying out productive drilling that can ensure water supply of the power station.**

In this case the lower hydrogeological levels are targeted and detailed. The upper layers are compiled.

The quantitative interpretation of the data from the electrical survey made it possible to establish the geoelectric log (Figure 4).

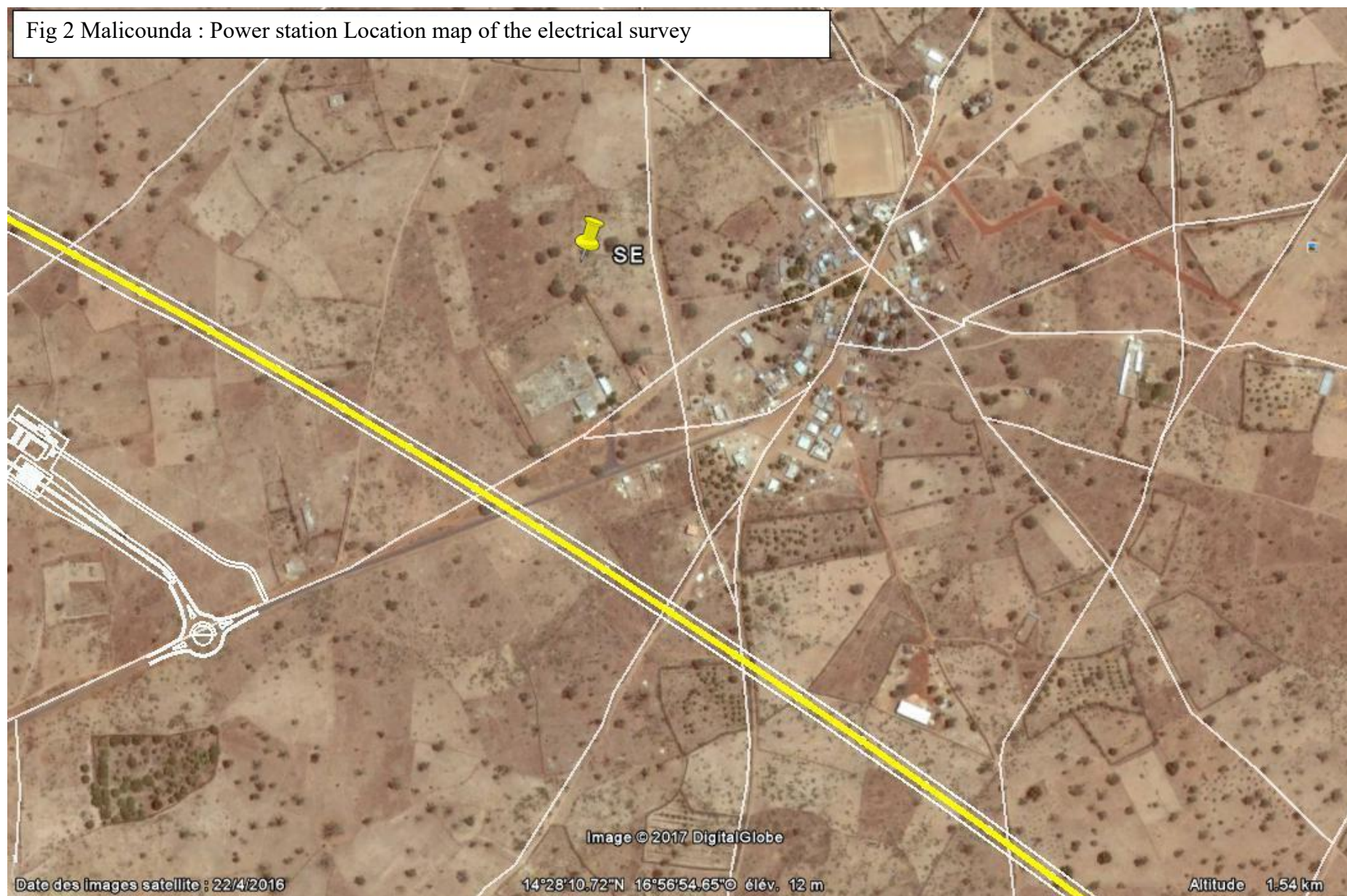
The analysis of the variation of the geoelectric resistivity values of the log made it possible to highlight, mainly, three levels of water table (Figure 4):

- **from 09 to 50 meters deep:** aquifer of marly calcareous with marly calcareous with brackish to salty water from the Paleocene
- **74 to 128 meters deep:** aquifer of calcareous with brackish to salty water
- **from 181 to 216 meters deep:** productive aquifer of more or less clay sands with fresh water from the Maastrichtian
- **below 216 meters deep:** productive aquifer of Maastrichtian freshwater clay sands

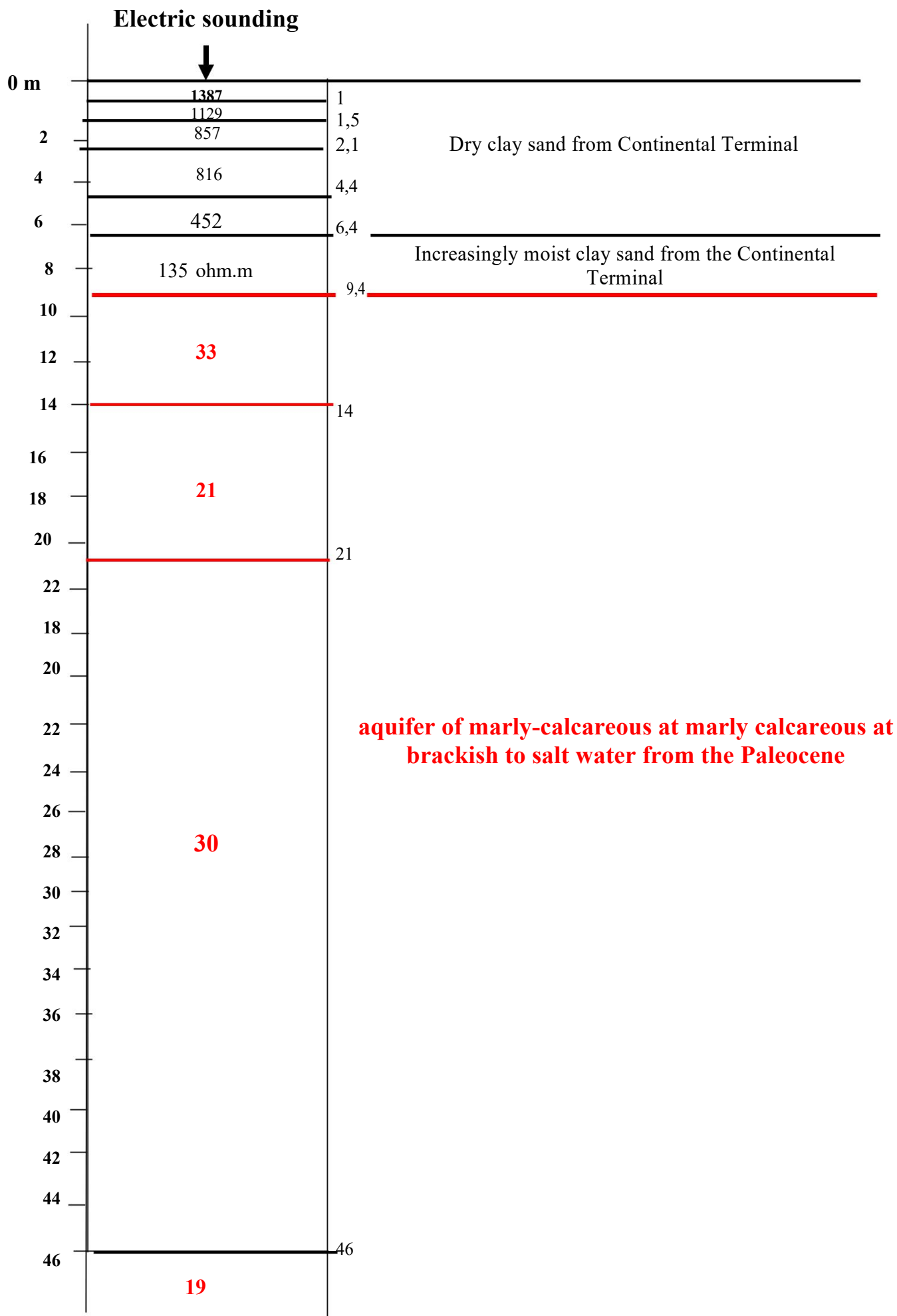
So this aquifer of the Maastrichtian clay sands constitutes the only freshwater aquifer favorable to the realization of productive drilling.

**The total depth of the borehole that captures this aquifer of the Maastrichtian clay sands may be up to 240 meters.**

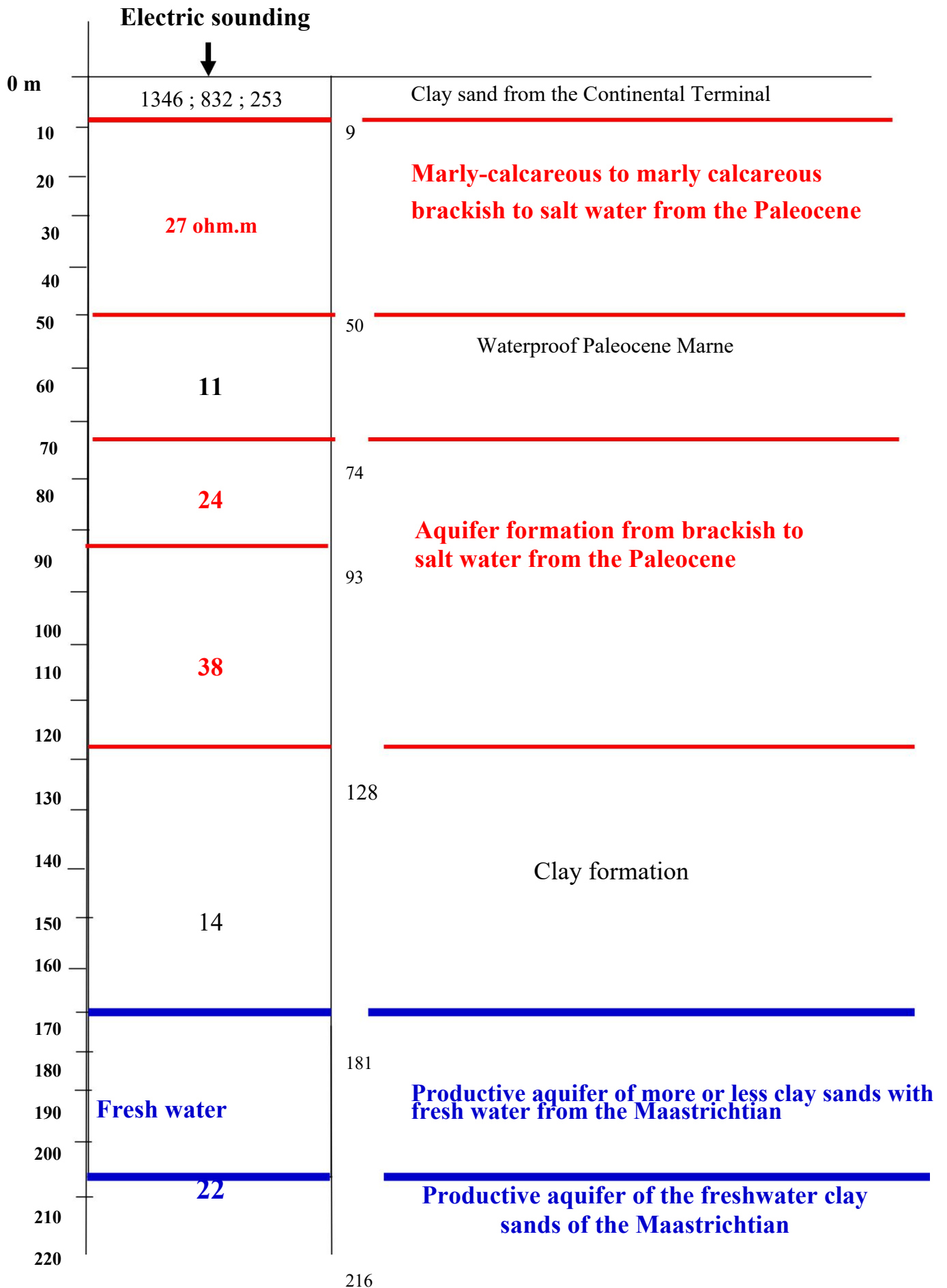
Fig 2 Malicounda : Power station Location map of the electrical survey



**Figure. 3: Malicounda: Power station: Detailed geoelectric resistivity of the layers from 0 to 50 meters deep for the installation of earth connections.**



**Figure. 4: Malicounda: Power station: Geoelectric log of the electrical survey carried out for the research of freshwater aquifer for drilling**



## GENERAL CONCLUSION

Three aquifers are present in this agricultural area:

- **from 09 to 50 meters deep**: aquifer of marly calcareous with marly calcareous with brackish to salty water from the Paleocene
- **74 to 128 meters deep**: the water aquifer of brackish to salt water
- **from 181 to 216 meters deep**: productive aquifer of more or less clay sands with fresh water from the Maastrichtian
- **below 216 meters deep**: the productive aquifer of the freshwater clay sands of the Maastrichtian

So this aquifer of the Maastrichtian clay sands constitutes the only freshwater aquifer favorable to the realization of productive drilling.

The **total depth of the borehole** that captures this aquifer of the Maastrichtian clay sands may be up to **240 meters**.

In this hydrogeological context, the length of **the pumping chamber of this borehole should go up to 137 meters deep, below of the calcareous of the located brackish to salt water.**

**The annular space of the pumping chamber must** be cemented over its entire length. This will help to cement the brackish water table of the Paleocene calcareous to prevent this salt water from intervening during the pumping operation of the borehole.

### **Important remark :**

Total and adequate cementing of the pumping chamber directory represents an essential operation for the success and sustainability of drilling.

### **Predictive technical characteristics of the drilling to be carried out in the power plant**

- **Total drilling depth**: up to **240** meters
- **Perform a complete logging operation** (resistivity, nuclear and PS) to specify the different levels of forecast capture
- **Cemented PVC pumping chamber length**, diameter 10 "3/4: 137 meters  
Drilling diameter 15 "1/2 10" 3/4

- **Casing steel dewatering tube in 4 "1/2 diameters:** from 126 to 210 meters with dielectric connection at the base.  
Drilling diameter 9 "7/2

The dewatering tube must enter the pumping chamber over a mandatory length of 10 meters, which is very adequately cemented.

- **4 "diameter stainless steel strainer level:** 210 to 234 meters deep Drilling diameter 9" 7/2
- **Stainless steel decanter tube in 4 "diameter:** 234 to 240 meters' deep Drilling diameter 9 "7/2
- **Top of gravel:** 150 meters

## ANNEX

Electrical survey and curve data



Maliounda SE  
(Centrale électrique)

26/12/2017

SONDAGE ELECTRIQUE -- TYPE SCHLUMBERGER										
MISSION:			DATE: / /			OPERATEUR:				
SONDAGE:			COORD:			ALT:			AZIMUT:	
E	AB/2	MN/2	K		V	I	Ps	V/I	Ro app.	obs
	m	m	$\pi * AM * AN / MN$		mV	mA	mV	ohm	ohm.m	
R	1	.5	2.36					571	1348	
J	2	.5	11.8					108	1274	
B	3	.5	27.5					38	1045	
R	4	.5	49.5					17.6	871	
J	5	.5	77.8					10	778	
B	7	.5	1	153	75.4			47	719	829
R	10	.5	1	313	155			1.5	35	490
J	15	.5	1	706	351			9.28	9.63	198
B	20		1		626			9.173		111
R	25	5	1	188	980			9.4	9.064	77
J	30	5	1	274	1412			9.15	9.034	41
B	35	5		376				9.081	9.018	30
R	40	5		495				9.0595		295
R	50	5		778				9.036		28
J	60	5		1123				9.0255		28.6
B	80	5	10	2002	989			9.013	9.003	26
R	100	10	5	1554.3	3132.1			9.0185	9.0084	29
J	125	10	5	2435.4	4898.4			9.0095	9.0042	23
B	150	10	15	3516.8	2331.45			9.023	9.0106	24.7
R	175	10	15	4792.4	3181.87			9.0042	9.007	20
J	200	10	20	6264.3	3108.6			9.0034	9.0015	21
B	250	10	20	9796.8	4874.8			9.004	9.005	19.6
R	300	10	20	14114.3	7033.6			9.0028	9.004	3.1
J	350	50	20	3768	9584.8			9.0082	9.003	3.1
B	400	50	20	4948	12528			9.005	9.0021	25
R	450	50	20	6283	15864			9.0037	9.0016	2.3
J	500	50	80	7775	4780.65			9.0035	9.0053	2.5
	600	50	80		6939.4				9.0045	3.1



Malicounda SE  
(Centrale électrique)

26/12/2017

Résistivité en  $\Omega m^2/m$

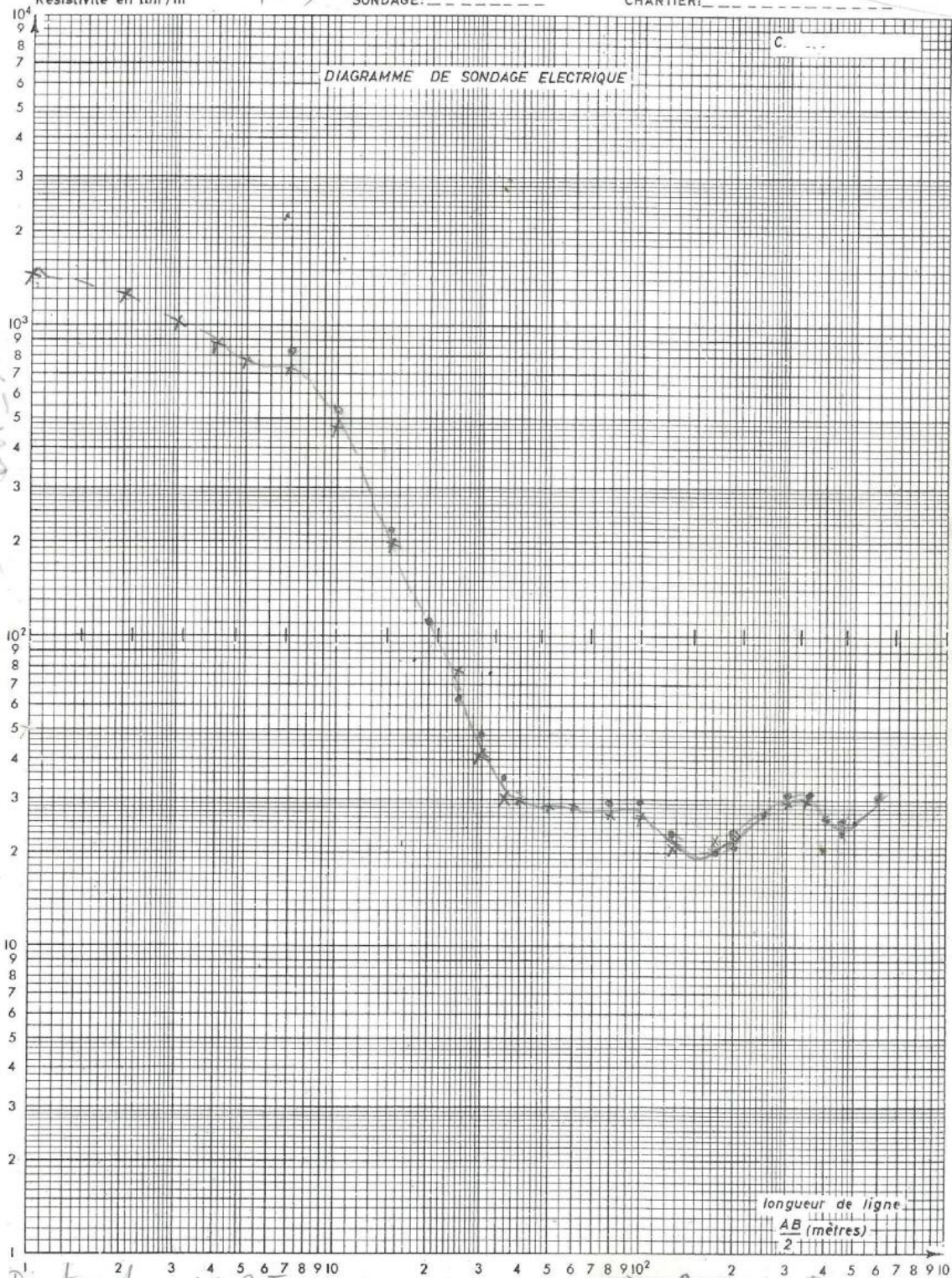
SONDAGE: \_\_\_\_\_

CHANTIER: \_\_\_\_\_

DIAGRAMME DE SONDAGE ELECTRIQUE

(61) L165659,0 L142818,9

MI=18



Point NSL = 10,05  
PIF = 12,30

Position ←

## **ANNEX 6.1: Evaluation of the effects of the gas phase explosion of a hydrocarbon tan**

The evaluation of the intensities of the effects of a fixed-roof atmospheric container explosion was conducted by using the calculation method developed by the GT-DLI. This method has been relatively widely used. *It consists in assimilating the explosion of a gas cloud to the explosion of a mass of TNT.* The overpressure effect distances are given by the following generic formula:

$$d_i = \lambda_i \cdot (M_{TNT})^{1/3}$$

with :

$$M_{TNT} = \frac{1}{Q_{TNT}} \cdot \frac{dP \cdot V}{(\gamma - 1)} \cdot (1 - F) \cdot \frac{1}{(1 + \varepsilon)^{(3\gamma - 3)}}$$

$$V = V_{GAZ} = 0,25 \cdot \pi \cdot DEQU^2 \cdot HEQU$$

$$dP = (PECL - PATM)$$

being,

$$d_i = \lambda_i \cdot (PECL - PATM) \cdot 0,25 \cdot \pi \cdot DEQU^2 \cdot HEQU \cdot (1-F)^{(1/3)} / Q_{TNT} \cdot (\gamma-1) \cdot (1+\varepsilon_{fr})^{3\gamma-3}$$

where:

DEQU: Diameter of the tank (m)

HEQU: Height of the tank (m)

PECL: Absolute burst pressure (Pa). On the basis of the technical considerations studied, the GT-DLI suggested:

- for tanks with a ratio  $r = \text{Height} / \text{Diameter}$  greater than 1, a burst pressure taken equal to 101,325 Pa relative (1 relative bar);
- for tanks whose ratio  $r$  is less than 1, the Burst Pressure will be taken as 50,663 Pa relative (0.5 bar relative).

PATM: Atmospheric pressure (Pa)

F: Fragmentation distribution energy factor (without unit).  $F = 0.6$  (value retained by the GT-DLI)

QTNT: TNT combustion heat (J / Kg).  $QTNT = 4690 \text{ kJ / kg}$

$\gamma$  = Report of specific heats (without unit).  $\gamma = 1.314$  whatever the stored product is.

$\varepsilon_{fr}$  : Deformation fraction of the material (without unit).  $\varepsilon_{fr}$  is taken equal to 0 by the GT-DLI, considering that this factor is already taken into account in the factor F

$\lambda_i$  : Reduced distance, depending on the desired overpressure threshold (20; 50 or 140 mbar), is obtained by reading the chart TM5-1300.

**NB :** the distances are determined from the center of the tank. Given the modeling dispersions for low overpressures, it was adopted for the 20 mbar overpressure an effect distance equal to twice the effect distance obtained for an overpressure of 50 mbar.

**Annex 6.2.1 : 3000 m3 HFO retention bowl fire of the tank**

## FNAP

### CASE OF A RECTANGULAR FIRE

1 / Input data:

Product name: DLI-Hydrocarbons

Atmospheric conditions:

Data	value	unit
Ambient temperature (value between 250 and 323 ° K)	298	K
Wind speed (value between 1.1 and 28 m / s)	2.7	m/s
Relative humidity (value between 0 and 1)	0.8	-

Tank geometry:

Data	Value	Unit
Length	85	m
Width	35	m
Height	0	m

Target data:

Data	Value	Unit
Target height	1.5	m

## FNAP

2/ results :

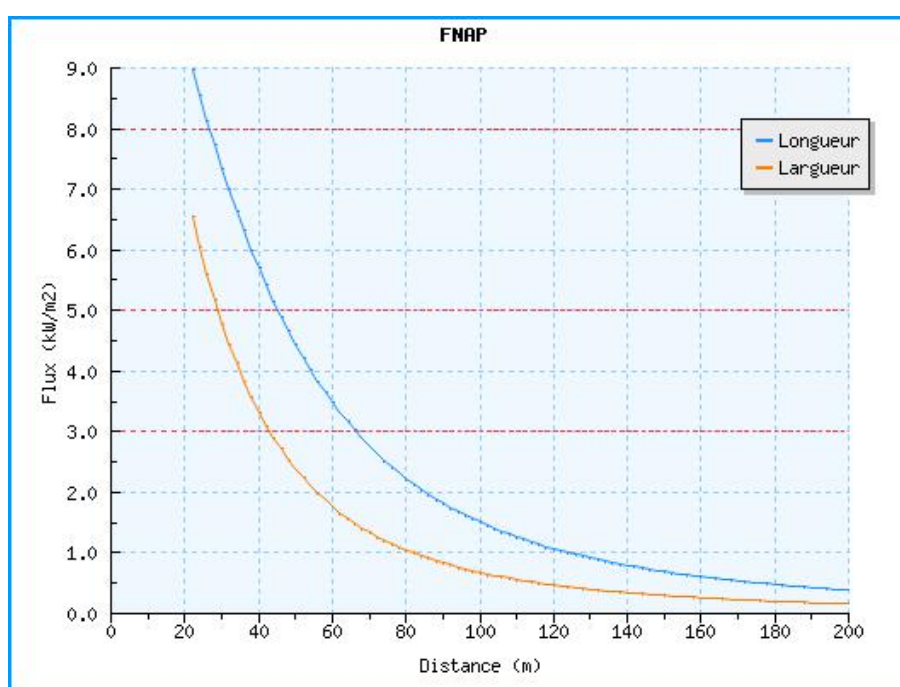
Thresholds:

Effects	Thresholds (kW/m <sup>2</sup> )	Distances (m)	
		Length	Width
Threshold for significant lethal effects (5%)	8	27	17
Threshold for lethal effects (1%)	5	45	29
Threshold for irreversible effects	3	66	43
Other effect threshold			

3/ Intermediate results:

Data	Value	Unit
Equivalent diameter	50	m
Flame length	46	m
Flame tilt	12	°
Flame height	45	m

4/ Graphic:







## **Annex 6.5 : Aria accidentology**

### **1. Accidental release of heavy fuel oil by a thermal power plant in the natural environment** *Accidents*

**N° 35748 - 17/01/2009 - FRANCE - 973 - REMIRE-MONTJOLY D35.11 - Electricity production**

During the night, when filling a 10 m<sup>3</sup> tank ("daily tank") in a power plant, 100 to 130 m<sup>3</sup> of toxic and persistent heavy fuel oil overflows to the associated remote retention, then to the polluted water network, which in turn feeds the rainwater networks by overflow. Between a few m<sup>3</sup> and a few tens of m<sup>3</sup> reach the North ditch along the access road to the establishment and the ditch located to the South of the establishment, feeding the neighboring wetland. The operator installs 3 filter dams at the level of the nearby river to limit the discharge of the natural environment and pumps the product spilled on the site and into the pipes. On Monday 18/01/2009, almost 48 hours after the start of the incident, it set up pumping means on the North ditch and was slow to intervene on the one located in the South. The operator does not inform the emergency services until 19/01. The firefighters install an additional dam in the terminal part of the creek. They carry out examination and note that the fuel oil has spread in a swampy area. The operator is installing an earth dam to prevent the spread of pollution to this site. He cures the creek and stores the soiled soil. The neighboring company provides pollution control equipment. The nearby river and the sea are not polluted. The prefecture and the inspectorate of classified installations are informed and supervise the storage of contaminated soil. The fuel oil was released into the natural environment through an interconnection between the group's dripping collection network and the rainwater network which is not treated. Heavy rains favored the spread of pollution and caused the storm basin to overflow. By mixing with the spilled hydrocarbons, they also complicated pumping operations, the hydrocarbon being pumped after decantation to be reinjected into a recovery system of the plant. No alarm reporting that the tank overflowed worked. A lack of maintenance could be the cause of this failure.

### **2. Leak of fuel oil in a thermal power plant. Accidents**

**N° 34004 - 18/12/2007 - FRANCE - 2A - AJACCIO D35.11 - Electricity production**

In a thermal power station, a FOD storage tank supplying a combustion turbine overflows into the dedicated retention park, a drain valve of which was not properly closed. The product then joins the SALIVE channel, in which a flow of 50 l of FOD is detected around 8 p.m., via the rainwater network. At 8:05 p.m., the retention valves are checked and closed. A floating dam is set up in SALIVE and the rainwater network is condemned interrupting the flow of FOD. The operator triggers the POI at 8.45 p.m. A pumping company skims the hydrocarbons on the canal and an earthmoving company clears the areas cluttered with reeds hampering this first operation. The operator spreads the absorbent around 22:10 hrs. to the right of the offending retention tank. A solid dam, made of earth and straw, is put in place at around 10:45 p.m. to stop any residual flow of water-FOD mixture in SALIVE and is then consolidated around 11:55 p.m. to secure the device for the night. Around midnight, the channel skimming ends and the POI is lifted. The site is folded around 1 am.

The pumped water-FOD mixture is poured into the plant decanter to undergo the treatment of plant effluents, the absorbent products spilled in the retention, earth and straw dams and soiled plants are placed in barrels and in tippers and supported by specialized companies. The operator defines corrective actions: search for an on-line hydrocarbon detection device in the flow of the watercourse, study of resizing and installation of a device for emptying the external gutter of the retention of the FOD tarpaulins the turbine, reinforcement of the lighting of the SALIVE canal, acquisition of movable tarpaulins for the recovery of effluents, study of the installation of a device for closing the SALIVE canal

### **3. Fuel oil leak in a thermal power station. Accidents**

**N° 37224 - 01/06/2009 - FRANCE - 78 - PORCHEVILLE D35.11 - Electricity production**

Around 11:20 am, during preparatory work for the requalifications after revision of unit 3 of a thermal power plant in the restarting phase, a strong smell of fuel oil is perceived by the operating agents during

the speed up phase of the turbine at 3000 rpm. Investigations around the boiler and at the HP oil station make it possible to locate a large flow under the insulation of a flow meter in the outgoing oil circuit.

1. The operators cut the lights on the boiler, stop the fuel oil and booster pumps and close the safety devices on the circuit. Absorbent products are spread around the edge of the flow area to protect from rainwater manholes.
2. A monitoring system is in place to detect any outbreak of fire or any new attack on the “rainwater” network.
3. Products spilled on the ground or present in the decanter-oil separator are pumped and then removed from the site. No pollution of the Seine was noted.
4. The origin of the leak is identified at a seal on the flow meter.
5. The operator installs a seal resistant to a temperature of 200 ° C. It is studying the option of replacing the same seals as a preventive measure on the other units and of creating a retention zone around the HP fuel oil substation.

#### **4. Oil pollution in a thermal power plant. Accidents**

**N° 20004 - 20/12/2000 - FRANCE - 67 - STRASBOURG D35.11 - Electricity production**

In a thermal power station, hydrocarbons are detected at the level of an inspection window for supply lines located in buried ducts. The offending pipeline is immediately repaired. The quantity spilled does not seem to require a depollution operation. However, a month later, during a check of groundwater prescribed by the prefectural authorization decree, the presence of floating hydrocarbons on the water table is detected 2 m north of the infiltration point. A week later, the operator sets up a larger fixing-pollution control device. It also indicates that the extent of the pollution is being checked. Monitoring of the water quality of the sprinkler wells located downstream of the site will then be ensured until the pollution is absorbed.

#### **5. Explosion of a steam generator. Accidents**

**N° 462 - 24/10/1988 - FRANCE - 67 - STRASBOURG D35.30 - Steam and air conditioning production and distribution**

A steam generator (38.8 MW) from a thermal power station exploded during the calibration of the pressure switches in the production circuit (60 bars). Three operators are thrown to the ground and burned to varying degrees. The team leader is ejected from the control room, suffering from internal burns. The damage is considerable: ripped heating body, 22 sectioned tubes, neighboring boiler moved 4 m away, nearby control room destroyed (estimate 60 MF). Tubes are projected 15 m into the fuel storage enclosure. Metal debris weighing 50 kg was found 80 m from the building. The explosion would be due to the extinction of one of the burners and the overheating of the lower tubes by combustion of the accumulated fuel oil.

#### **6. Empty and degassed fuel tank fire. Accidents**

**N° 30516 - 26/08/2005 - FRANCE - 95 - SARCELLES D35.3- Production and distribution of steam and air conditioning**

Following welding work for the installation of safety equipment in a thermal power plant, a fire broke out on the interior lining on a 1000 m<sup>3</sup> heavy fuel tank that was emptied, degassed but not cleaned. Firefighters quickly alerted protect the second tank of 1000 m<sup>3</sup> 95% full adjoining the tank on fire and extinguish the fire. No impact has been noted on the operation of the facilities or on the environment. Fire water confined to the site were evacuated. A specialized company will check the condition of the tank.

## **7. Incident in a thermal power station. Accidents**

**N° 102 - 01/08/1988 - JAPON - 00 - AMAGASAKI D35.1 - Electricity production, transport and distribution.**

Following its fouling by a fuel mist, the catalyst of a boiler of a thermal power station melts and by contact causes the wall of the air heater to melt. The water used to cool the unit externally enters through the hole formed and vaporizes violently. An explosion occurs 3 hours after the start of cooling operations and kills 2 employees (busy studying experimentally in situ the conditions of formation of the oil mist observed) and injures 13 other people.

## **8. Fire in a power station (coal / heavy fuel oil). Accidents**

**N° 15013 - 01/02/1999 - FRANCE - 59 - BOUCHAIN D35.11 - Electricity production**

In a thermal power station (2 units 1 heavy coal / fuel oil), a fire broke out on an electrostatic dust collector 12 hours after the unit 1 was put back into service.

Around 3 a.m., the unit, restarted the day before at the end of the afternoon, is coupled to the network with progressive ramp-up. During 1 hour 40 minutes, a lack of combustion air due to a failure in the air flow regulation chain (due to an incorrect value of the steam flow which is involved in the creation of the control signal) causes poor combustion and entrainment of 80 tons of unburnt and hot pulverized coal up to the main dust collector where it burns, with explosion (bursting of part of the mass supporting the axis of the draft fan, tearing of a ferrule from the fan, deformation of the soot shipping hatch). The shift team did not notice the fire in the dust collector until 6:50 a.m. and set off the facilities and the POI.

The firefighters, on the scene at 7.20 am, find it difficult to control the fire because of the large and closed structure of the dust collector. The intervention ends the next day at 1 p.m. The extinguishing water was collected and then evacuated. The reactivation of the unit will take several months. Damage is assessed at 30 MF.

The operator implements a series of measures:

- improvement of procedures and operating methods and awareness of operational teams,
- improving the dissemination of local and national feedback to teams,
- technical changes to the instrumentation (addition of P, T and oxygen concentration alarms, measurement of unburnt substances, etc.)
- The POI, although not yet validated, has proven its effectiveness in the coordination of rescue operations, in particular with the provision of a fixed, equipped PC (means of communication, tables, installation plans, etc.) and means of measurement (toxicity, O<sub>2</sub> and CO concentrations, etc.). In addition, decision support procedures in the event of an accident are put in place at national level.

## **9. Fire in a thermal power station. Accidents**

**N° 32177 - 03/09/2006 - FRANCE - 2B – LUCCIANA D35.11 – Electricity production**

At 9:56 a.m., 2 employees of a thermal power station producing electricity noticed a leak in the return circuit of the fuel supply for group No. 6 (G6) located in the basement. The driver makes a change of fuel (heavy fuel oil with FOD), to avoid fouling of the cylinders, before stopping and securing the G5 / 8 assembly, with a power of 44 MW. The FOD projected on the right turbo of the engine, via the crack in the pipe, ignites at 10:05 am, forming a ball of fire probably due to the ignition of the oil mist. Officers try to control the fire with fire extinguishers, but the fire spreads quickly. They alert the firefighters and set up the fire motor pump located in the basement at 10:07 am. The driver stops the other 3 groups in

section 5/8. At 10h12, the emergency services attacked the fire with a lance on G5 and G6 and cooled G7 and G8. The driver stops the G5 / 8 booster pumps. At 10:20 am, the fire spreads to G7 and G8 giving off thick smoke. At 10:30 am, the driver stops the 1/4 section and evacuates the control room. The POI is implemented. To avoid water pollution, the ultimate barrier valve is closed. A nearby establishment provides additional firefighting foam. The “superheated water” valve is closed. The fire was circumscribed at 11:20 am and extinguished at 2:21 pm after a resumption of cable fire. Drips of HC, the presence of 12m<sup>3</sup> of oil, drained from the group and stored on a tarpaulin in anticipation of its maintenance, open fire doors, impossible access to stop controls and isolation valves between the modules and the fuel rails due to the flames and the deterioration of the cuff connection contributed to the maintenance of the fire and its extension. The automatic fire extinguishing system, however, helped prevent the spread of flames to the upper floors. During the operations, the emergency services secured the external FOD tanks located near the buildings. 2 employees are taken to the hospital: one very slightly burned on the arm, the other inconvenienced by the smoke. The fire spread to exterior buildings destroying the control room, the premises housing the compressors and the emergency generator. The 5/8 unit will be unavailable for 12 to 14 months and a loss of production is deplored, but there has been no interruption of electricity supply to users. The crack in the pipe would have been caused by engine vibrations. This problem having already been identified, vibratory decoupling hoses had been put in place. The inspection noted the facts, the plant was already under the threat of a formal PA for non-compliance with safety-related provisions. The operator reminds that fire prevention actions were not always applied and suggests corrective material and organizational actions.

## **10. Historical Boil-over. Accidents**

**N° 6052 - 19/12/1982 - VENEZUELA - 00 – TACOA D35.11 – Electricity production**

In a thermal power plant, the superheated gas phase (80 ° C instead of 65 ° C) of a 40,000 m<sup>3</sup> tank filled with 40% heavy fuel oil (FO - PE = 71 ° C) explodes (ignition by 2 employees during gauging work). The ejected frangible fixed roof falls back into the 33,000 m<sup>3</sup> bowl (= greater than rupture of a FO line = greater than bowl fire). After 6 hours of tank fire, a boil-over occurs. A ball of fire rises above 300 m, a wave of burning hydrocarbons submerges the merlons (H = 6m) and extends up to 400 m below. In the process, it floods the bowl with another OF bin (bowl fire = greater than tank pressure = greater than roof opening = greater than 20 days of bin fire) destroys 60 vehicles located on the single access road as well as 70 homes and 2/3 of the power plant. 160 people are killed including 40 firefighters, 500 other people are injured. The total cost of the damage is estimated at 300 MF. The only narrow, winding access road to the ferry runs below the basin. It is crowded with emergency vehicles, press and many onlookers. The fall of the roof destroys the 4 ' sprinkler crown. Forty thousand people, mainly slum dwellers, are evacuated by the army and rehoused in tents.

## **11. Oil spill in a thermal power station. Accidents**

**N° 47919 - 07/10/2015 - FRANCE - 973 - REMIRE-MONTJOLY D35.11 – Electricity production**

Around 1 p.m., in a thermal power plant classified as Seveso low threshold, an employee noticed a large spill of fuel oil on the ground. Hydrocarbons are discharged by a pump submerged in the rainwater network. The employee stops this pump and gives the alert. The release, estimated at 100 m<sup>3</sup>, spreads under an installation of photovoltaic panels on the site. This is due to the overflow of an oil tank. The incident takes place in an unusual context. The operation of the plant has been severely disrupted by a strike for 10 days. The strikers limit access to only the requisitioned driving teams. The day before the accident, in order to unload a ship, lineage operations were carried out on an oil tank. A deposit system, based solely on a visual position statement, has been put in place. During the night, the positioning of several valves was changed. 2 tanks were put in communication leading to the filling by gravity of the oil tank. This bin is equipped with a high level and, a very high level. Both activate visual and audible alarms. Only the visual alarms were activated in the control room, the audible alarms

were out of service. The visual alarms were not perceived by the operators in the control room and the bin overflowed. The fuel flowed through the overflow into the retention of the tank which is not equipped with an oil detector. The containment isolation valve was open. The oil then flowed to the rainwater network. In normal operation, this network leads to a storm basin. During the accident, the storm basin was under construction. Its supply was blocked. The rainwater network was purged using a submerged pump which discharged directly into the natural environment. The fuel oil overflowed from the tank, spilled in the retention, then in the rainwater network before being discharged by the pump.

Following this pollution, the inspection of classified installations goes to the site. It recommends that the operator strengthen the technical and organizational safety barriers. It requests in particular the implementation of mechanical locking of the orders of the transfer organs when carrying out a consignment scheme. A review of the danger study, integrating the demands of the inspection as well as the assessment of the risks associated with social movements, is also requested.

## **12. Explosion on a boiler of a thermal power station. Accidents**

**N° 25754 - 28/11/1984 - FRANCE - 76 - LE HAVRE***D35.11 – Electricity production*

An explosion occurs on a new boiler in a thermal power station (10 t of steam / h). This auxiliary boiler was intended to supplement the supply of steam necessary for heating the heavy fuel oil in the storage facilities and for cooling the burners of unit 3. It is a boiler with a corrugated hearth tube and 3 smoke paths. The combustion gases are directed to the rear of the boiler and then brought forward by the lower smoke tubes before being returned to the chimney located at the rear via the upper tubes. It had to operate with buffer on the network, in parallel with another boiler of the same type (stopped on the day of the accident) and with steam transformers producing steam from the turbo alternators.

The accident occurred at the end of the boiler start-up tests, which was supervised by a technician from the product manufacturing company and 2 technicians from the boiler room. During the accident, one end of the furnace tube separated from the tube plate, creating a breach on the rear face of the boiler. The water contained in the boiler, under the action of the instantaneous vaporization of the steam under pressure (13 bar), escaped through this breach, propelled by reaction the boiler ten meters behind and causing its embedding in the scrubber of a 250 MW boiler. The steam escaping from the boiler passed through the handling bay, blown the wall of the mechanical workshop and by partially vaporizing at atmospheric pressure, occupied a much larger volume, causing burns to the personnel occupying this workshop.

The death toll from the explosion is 1 dead and 17 injured; all were in the mechanical workshop. Although for some calculation codes, the characteristics of the boiler are not acceptable, the latter nevertheless complied with the rules of the ISO code and the French standard NFE 32.104. Hydrocarbons heavier than water at boiler operating temperature were present in the feed water. They are deposited on the hearth tube which would cause vaporization into film and therefore an increase in the temperature of the metal which becomes higher than the maximum guarantee temperature of the characteristics of the steel used. There are indeed possibilities of pollution of the steam circuit by fuel oil or during its reheating: during the recovery of steam condensates, it can be admitted in the tarpaulins which are used to supply the boiler. As the actual operating conditions at the time of the explosion were not known with certainty, the combination of the presence of fuel oil in the supply water and the limiting design characteristics meant that the accident took place.

## **13. Accidental release of heavy fuel oil by a thermal power station in the natural environment. Accidents**

**N° 35748 - 17/01/2009 - FRANCE - 973 - REMIRE-MONTJOLY***D35.11 – Electricity production*

During the night, when filling a 10 m<sup>3</sup> tank (“daily tank”) in a power plant, 100 to 130 m<sup>3</sup> of toxic and persistent heavy fuel oil overflows to the associated remote retention, then to the polluted water network, which in turn feeds the rainwater networks by overflow. Between a few m<sup>3</sup> and a few tens of m<sup>3</sup> reach the North ditch along the access road to the establishment and the ditch located to the South of the establishment, feeding the neighboring wetland. The operator installs 3 filter dams at the level of the nearby river to limit the discharge into the natural environment and pumps the product spilled on the site and into the pipes. On Monday 18/01/2009, almost 48 hours after the start of the incident, it set up pumping means on the North ditch and was slow to intervene on the one located in the South. The operator does not inform the emergency services until 19/01. The firefighters install an additional dam in the terminal part of the creek. They carry out surveys and note that the fuel oil has spread in a swampy area. The operator is installing an earth dam to prevent the spread of pollution to this site. He fixes the creek and stores the soiled soil. The neighboring company provides pollution control equipment. The nearby river and the sea are not polluted. The prefecture and the inspectorate of classified installations are informed and supervise the storage of contaminated soil. The fuel oil was released into the natural environment through an interconnection between the group's dripping collection network and the rainwater network which is not treated. Heavy rains favored the spread of pollution and caused the storm basin to overflow. By mixing with the spilled hydrocarbons, they also complicated pumping operations, the hydrocarbon being pumped after decantation to be reinjected into a recovery system of the plant. No alarm reporting that the tank overflowed worked. A lack of maintenance could be the cause of this failure.

#### **14. Overflow from the decanter of a power plant. Accidents**

**N° 40969 - 22/09/2011 - FRANCE - 972 – BELLEFONTAINE D35.11 – Electricity production**

At 6 a.m. during the shift take-up inspection, the shift team from an oil-fired thermal power station located by the sea detected hydrocarbons in the storm and industrial water discharge channel at the downstream of the settling tank. The operations manager orders the immediate closure of the gates of the downstream part of the canal to contain the pollution, as well as the verification of all the installations. At 7:30 am, the shift supervisor reported coastal oil pollution around the wharf downstream from the discharge channel.

At the order of the operations manager, site personnel redeployed at 7.50 am a floating dam already in place for the unloading of a heavy fuel oil vessel scheduled for the day. As soon as they arrive, the emergency services benefit from the support of 2 pollution control experts from the operator who participated the day before in an exercise on this site. Absorbents are placed all around the rejection area delimited by the mouth of the canal, the floating dam and the riprap of the wharf. A private company collects and disposes of 70 m<sup>3</sup> of polluted water, as well as contaminated absorbents. On the morning of the day of the accident, the operator issued a press release and gave interviews to local radio and television.

The site's wastewater treatment facility includes upstream downstream settling tanks, treatment tanks and a discharge channel. A chain of material and human failures has been observed. The pump for lifting a diesel generator sump recovery sump did not stop at its low level, continuing to operate until it was removed by the shift officers. A centrifuge also malfunctioned and massively rejected fuel oil. These two failures led to a massive arrival of hydrocarbons in the settling basins, the water / hydrocarbon separators of which were saturated, allowing pollutants to flow into the treatment basins. These include 2 independent devices: 2 oleofilters on the one hand and 1 aeroflocculator on the other hand. At approximately 4:00 am, during a 2-hour monitoring round and when the oil filters were not in operation, an employee noticed that the aeroflocculator was discharging oil into the discharge channel. He stopped the equipment pump but, contrary to the instructions, failed to warn the block chief, to close the valves between the aeroflocculator and the discharge channel and to perform a visual inspection of this.

Furthermore, no anomaly was detected in the control room because the 2 monitoring booths by continuous measurement of the hydrocarbon contents in the rejection channel had been inoperative since 15/09 (the breakdown notification was in progress treatment). Material and human dysfunctions were finally aggravated by abundant precipitation (1 m of water in 24 hours). The operator rehabilitates defective equipment, performs an audit of the industrial water treatment installation, cleans up the

discharge channel, analyzes its monitoring procedures and educates all of its personnel. An exercise combining state services is planned for the following year.

## **15. Fuel oil leak in a power plant. Accidents**

**N° 46908 - 19/07/2015 - FRANCE - 987 – PUNAAUIA D35.11 – Electricity production**

Around noon, a heavy fuel oil leak was discovered in the hydrocarbon storage area of a thermal power station. The source of the leak is found in a pipe, downstream of a transfer pump. The fuel oil is projected against the wall of a retention basin. This causes misting of the liquid. As soon as it is detected, the operator stops the transfer pump. He set up anti-pollution barriers around the site and called on-call teams for intervention. 10 m<sup>3</sup> of fuel oil is released, but remains inside the site.

The cleaning and oil recovery operations begin around 2 p.m. The piping is repaired. The operator excavates 20 m<sup>3</sup> of polluted soil.

The cause of the leak was a fatigue break in a nozzle on the heavy fuel transfer piping. This rupture is located upstream of a branch valve. An improper fitting of the nozzle (excessively large offset) and the strong vibrations undergone by the piping have induced excessive fatigue stress on the nozzle.

The operator eliminates unnecessary tapping on his installation. It makes modifications to the retention basins in order to strengthen their tightness. He also decides to make the transfers during working hours.

## **16. Fire in a power station. Accidents**

**N° 33899 - 22/11/2007 - FRANCE - 974 - LE PORT D35.11 – Electricity production**

In a thermal power plant, a very smoke-producing fire was detected at 1:05 p.m. on diesel group No. 35. The groups located in the same room were stopped; an operator closes the fire valves of the oil, diesel and fuel oil circuits and the fixed sprinkling of motors No. 35 and 36, located side by side, is activated. Staff are evacuated and the POI is triggered at 1:10 p.m. Operators use foam lances and water curtains before firefighters arrive. The fire was brought under control at 1:23 p.m. The ventilation of the building is stopped, the damaged installations are electrically isolated and the compressed air tanks are purged. The emergency services cool the engine, as well as the engine lubricating oil that has flowed into the outer channel using internal means and a foam lance. The building is ventilated and, after checking the installations, the operator rises the POI at 5.45 p.m. The inspection of classified installations is kept informed of the progress of the event. The operator communicates directly with local residents on the management of the event, calls on the media to inform the population of the impact of the incident on the electricity network and ask them to moderate their consumption of electricity, then organizes information meetings public.

The air monitoring support team did not detect a peak in pollution linked to this fire. Liquid effluents for sprinkling and extinguishing the fire are confined to the site and then transferred to a dedicated tank before specific treatment. After verification, the diesel generators were gradually put back into service on 26/11 and on 29/11, engines no. 35 and 36 were restarted at the end of 2007.

A supply pipe to the oil purifier for diesel generator no. 35, replaced shortly before the accident, broke suddenly releasing the superheated oil at 5 bar on an exhaust pipe downstream of the turbocharger with a surface temperature of 400 ° C and on contact with which it ignited. The oil supply being maintained by a pump coupled to the diesel engine, the emergency stops of the latter and its gradual reduction in speed would have maintained at the level of rupture sufficient oil pressure and flow to fuel the fire. Continuous training and regular exercises enabled the staff to control the incident. The operator investigates the causes of this accident, plans the modifications to be made to the installation to avoid the risks of frank rupture of piping and to minimize the consequences and communicates with the neighborhood on the good understanding of the systems.



## **17. Fire of a transformer in a power plant. Accidents**

**N° 39184 - 09/05/2010 - FRANCE - 2A – AJACCIO** *D35.11 – Electricity production*

At 10:12 p.m. in a heavy fuel oil thermal power station, the fire alarm system of a generator draw-off transformer in operation was triggered. After visually observing the presence of flames, the supervisor disconnects the group which is then stopped by the block chief. At the same time, 3 members of the operating team equip themselves with ARI, descend into the smoky gallery where the transformer is located and extinguish the fire at 10:21 p.m. using a mobile CO2 extinguisher of 20 kg. The speed of the intervention is due to the simultaneous presence of 5 employees at the control station when the alarm was triggered. The firefighters were not called and the POI was not triggered. The Inspectorate of Classified Installations, the CHSCT and the Labor Inspectorate are informed, as is occupational medicine.

The analysis of the transformer built in 1986, put into service in 1993 and revised at the end of 2009 shows that a short circuit has occurred between turns. No overvoltage, overcurrent or excessive temperature having been detected, the operator attributes this malfunction to aging of the dielectric made of resin and paper.

The operator decided to replace all transformers of the same type within 15 months, to install a video surveillance system and to strengthen maintenance.

## **18. Fuel oil leak in a thermal power plant. Accidents**

**N° 34718 - 16/06/2008 - FRANCE - 44 – CORDEMAIS** *D35.11 – Electricity production*

In a thermal power station, a heavy fuel oil leak occurred at around 9 p.m. on a unit shutdown since early February for connection work on a smoke denitrification unit. The rejection was not detected until the next day at around 7 a.m.: 30 m<sup>3</sup> of hydrocarbons had flowed into the internal network and the retention tank. The leak is stopped by closing a valve that was not properly closed. The other valves are checked. The visual checks carried out on the LOIRE and in the plant's installations do not make it possible to detect any impact on the environment. As a precaution, absorbent products are still put in place around the retention circuits. The fuel oil retained in the plant's installations is pumped and will be reinjected into production. The equipment departments, the gendarmerie, a representative of the prefecture and Inspection of Classified Installations go to the site. The latter is carrying out an inspection visit. The operator issues a press release.

## **19. Fire in the envelope of a steam generator. Accidents**

**N° 20039 - 07/03/2001 - FRANCE - 78 – PORCHEVILLE** *D35.11 – Electricity production*

In a thermal power plant, a fire broke out at 3 a.m. on the envelope of a steam generator 40 m high from one of the sections which had been shut down since 11 p.m. At 12:30 a.m., the night operations crew noted around 0:30 a.m. that the pressure had not dropped to normal and that the burners were still hot. The POI is triggered and the firefighters mobilized. The rupture of a domestic fuel oil tap in the open position was the cause of the accident

.

## **20. Fire on an oil tank in a thermal power station. Accidents**

**N° 36192 - 29/05/2009 - FRANCE - 13 – MARTIGUES** *D35.11 – Electricity production*

In section 4 of a thermal power station, a fire started at around 1:20 p.m. on an unexploited 20 m<sup>3</sup> oil bowl and on plastic film. The POI is triggered and 4 people are evacuated. Outside firefighters helped by those on site extinguish the fire in 10 min with 2 foam lances. The site facilities are being modified, some parts of the factory are being changed from oil to natural gas. In this context, some equipment is pulled to pieces, others modified or retained.

## **Annex 7.1 DUP DECREE**

REPUBLIC OF SENEGAL

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MINISTRY OF ECONOMY  
FINANCE AND PLANNING

### PRESENTATION REPORT

In accordance with the letter dated 15 March 2018, the Minister of Petroleum and Energies requested the declaration of public utility of the project to build the 120 MW power station planned for Malicounda.

The energy purchase contract for this project has already been signed and is part of the validated production.

The project land, covering an area of 15 hectares depending on the national domain, was allocated for the establishment of a power station in Malicounda Wolof, following deliberation no 2/CRM of January 27, 2012 of the former Malicounda Rural Council.

The Control Commission of the State Operations, during its in-home consultation dated May 15, 2018, issued a notice in favor of the regularization by lease of said land for the benefit of SENELEC, for the purpose of the realization of said power plant .

Given the legal nature of the land, it is necessary, in accordance with article 380 of the code of civil and commercial obligations, to prescribe, beforehand, its registration in the name of the State of Senegal.

The attached draft decree, developed in application of the combined provisions of Law 64-46 of June 17, 1964 of the national domain, Law 76-66 of July 2, 1976 of the State domain code and Law 76-67 of July 2, 1976 of the expropriation for reasons of public utility and to other estate operations of public utility, was prepared to:

- Declare of public utility the project to install a 120 MW power station on a 15 hectare base plot located in Malicounda;
- Prescribe its registration in the name of the State;
- Declare its disaffection.

For the Minister of Economy and Planning and by Delegation  
The delegated Minister in charge of the Budget  
Birima Mangara (Signature)

**DECREE n° 2018-1081**

Declaring of public utility the project to install a 120 MW power station on a 15-hectare base plot in Malicounda; prescribing its registration in the name of the State and declaring its disaffection.

**THE PRESIDENT OF THE REPUBLIC**

GIVEN the constitution;  
GIVEN Law No. 64-46 of June 17, 1964 of the national domain;  
GIVEN Law No. 76-66 of 02 July 1976 of the State Domain Code;  
GIVEN Law No. 76-67 of July 2, 1976 of expropriation for reasons of public utility and to other estate operations of public utility;  
GIVEN Decree No. 64-573 of July 30, 1964 stipulating the conditions for the application of Law No. 64-46 of June 17, 1964 mentioned above;  
GIVEN Decree No. 77-563 of July 3, 1977 for implementing the above-mentioned Law No. 76-67 of July 02, 1976;  
GIVEN Decree No. 2017 -1531 of 06 September 2017 for appointing the Prime Minister;  
GIVEN Decree No. 2017 -1533 of September 07, 2017 for establishing the composition of the Government;  
GIVEN Decree No. 2017 -1546 of 08 September 2017 for the distribution of State Services and control of public establishments, national companies and companies with public participation between the Presidency of the Republic, the Prime Minister's Office and the ministries, modified by Decree No. 2018-683 of March 27, 2018;  
GIVEN the request of the concerned party;  
GIVEN the favorable opinion of the State Operations Control Commission during its in-home consultation of May 15, 2018;  
GIVEN the report of the Minister of the Economy, Finance and Planning;

**ENACT:**

**Article 1** - The project to install a 120 MW power station on 15 hectares of land, located in Malicounda, is declared of public utility.

**Article 2:** Registration of the said land in the name of the State is prescribed.

**Article 3:** Disaffection is declared.

**Article 4:** The Minister of Economy, Finance and Planning is responsible for the implementation of this decree which will be published in the Official gazette of the Republic of Senegal.

Macky SALL (Signature)  
Dakar, June 04, 2018

By the President of the Republic  
The Prime Minister  
Mahammed Boun Abdallah DIONNE (Signature)

## **Annex 7.2 AGEROUTE Letter –Construction site**

## SENELEC

GENERAL DIRECTORATE

Date-  
Mister Ibrahima NDIAYE  
AGEROUTE General Director  
street F x David DIOP  
Fann residence  
BP :25 242  
Dakar-Fann

**Ref.** DP/DGCI/SEP/-TOK/YF/KN/sna/N° 138/2018

**Object:** Malicounda 120 MW power station project

Request for information relating to the Tar road  
and Mbour-Fatick Highway

Director General,

As part of Malicounda 120 MW power station construction project, environmental and social impact studies are being finalized by the Engineering Environment Cabinet Services (EES SARL).

In this regard, the quantification of atmospheric emissions in the neighborhood of this plant in order to ensure good air quality is a requirement of the environment code and the performance standards of providers (WHO Standards and Performance Standards of IFC / BM)

Knowledge of the forecasts relating to atmospheric emissions at Mbour-Fatick Motorway will allow better modeling of the cumulative atmospheric dispersion of emissions and will not exceed the tolerance thresholds, near the power plant.

So, in order to allow us to finalize the study on atmospheric dispersion, kindly provide Senelec with the following information around the village of Malicounda:

- **Average daily traffic: traffic speed - share of light vehicles, heavy vehicles and 2 wheels;**
- **The emission factors used to estimate the emissions from this site.**

The Tar road which connects the RN 1 to the village of Malicounda Wolof is in a state of disrepair and requires repair. This road passes in front of Malicounda power station, which is located near this village. It is very likely that the heavy trucks transporting the materials and equipment of the plant during the construction phase take this route.

SENELEC

**Selenec wants to know if there is a plan to rehabilitate this Tar road as part of the Mbour-Fatick highway project**

also, in order to route the engine convoys, which will have a load of around 400 tons, a Bolloré study has identified an optimal route for bringing the engines to the project site, but presenting three obstacles (1) RN1 bridge between Diass and Sindia; (2) crossroads of highway and RN1 after Nguékhokh; and (3) crossing Malicounda road with highway at Péage.

The obstacles (2) and (3) will be bypassed by borrowing from the highway construction site, after Nguékhokh.

**we ask you to confirm that this site track will be maintained to allow us to overcome these two obstacles.** Note that the extension of this track to the project site is the responsibility of the promoter and that the arrival of the groups is scheduled for the first half of 2019. This point was discussed with the representatives of Ageroute during the meeting of May 22, 2018 within the framework of the working group set up by the energy Secretariat.

Referring to the same subject, in order to allow the study for the shoring of the RN1 bridge between Diass and Sindia-obstacle (1) documents were made available to the working group for the realization of the calculation note.

**We seek your expertise on this subject and ask you to provide us with documents with transmission slip.**

Thanking you in advance for your collaboration, please accept, Mr. Director General, the expression of my distinguished consideration.

The Director General  
Abdoulaye Dia  
(Signature and seal)

**Copy:**

- ✓ Permanent Energy secretariat

**Attached document:**

- ✓ PV meeting of May 22, 2018 at the SPE



### **Annex 7.3 Abstract of agreement- SENELEC-DEFCCS**

**REPUBLIC OF SENEGAL**  
**A nation – a purpose – a faith**  
\*\*\*\*\*

**PARTNERSHIP AGREEMENT**

**BETWEEN**

**Senegalese Electricity Company**

**"Senelec"**

**AND**

**The Department of Water and Forests, Hunting and Soil Conservation of the Ministry of the  
Environment and Sustainable Development, known as "DEFCCS"**

**FOR PROJECTS RELATING TO:**

**INSTALLATION, MAINTENANCE OF TRANSPORT LINES, ELECTRICAL  
DISTRIBUTION BY SENELEC AND MITIGATION OF THEIR NEGATIVE IMPACTS ON  
FOREST DEVELOPMENTS**

..... 2017

# **PARTNERSHIP AGREEMENT**

## **Concluded**

### **BETWEEN**

The Directorate of Water and Forests, Hunting and Soil Conservation of the Ministry of the Environment and Sustainable Development located at the Parc Forestier du Hann BP 1831 Dakar tel: (221) 33.831.01.01, represented by its Director, Colonel Baïdy BA duly authorized for this purpose (hereinafter referred to as "DEFCCS")

### **And**

Senelec, a public limited company with majority public participation under Senegalese law, with the capital of One hundred seventy-five billion two hundred thirty-six million three hundred and forty-four thousand five hundred and twenty-five (175,236,344,525) CFA francs, having its registered office in 28, Vincens street BP 93 Dakar Senegal, registered at the register of trade and Credit Mobilier under the number SN DK 84 B 30, NINEA NO.00140012G3, represented by its director general, Mr. Mouhamadou Makhtar CISSE, duly authorized for this purpose , (hereinafter called "SENELEC")

DEFCCS and Senelec, hereinafter collectively referred to as the "Parties" or individually by the "Party"

### **PREAMBLE**

In its determination to improve the supply and distribution of energy to customers throughout the national territory, Senelec is involved in a set of projects and programs for carrying out transmission and distribution of its electrical network.

Projections show the need to strengthen the interconnected network in any country, particularly in the South, to reduce operating costs, technical losses and to densify the energy distribution network.

In this sense, an electrical Transmission and Distribution network connection scheme across the country has been drawn up by Senelec for 2030, with a large program for the installation of high-voltage electrical substations and the installation of 225 KV lines and connection and rehabilitation of 30 KV links in localities.

All this equipment and installations (substations, transformers and power lines of 225 KV, 90 KV, 30 KV AND 6.6 KV) constitute the electrical network comprising a set of more or less available energy infrastructures which makes it possible to convey the electrical energy of the production centers towards electricity consumers.

The extension of the electrical network, subject of the various projects undertaken by Senelec, will have impacts on all along the routes of power lines, a significant part of the forests, particularly in the

natural region of Casamance. Activities such as clearing rights of way, creating access roads, installing pylon stakes

SENELEC, anxious to contribute to the protection of the forest heritage, undertakes to comply with the requirements of the Forest Code. Thus, all major projects monitored by SENELEC are subject to the technical opinion of the forest service to study the impacts on the State's forest domain and on forest species outside the classified area. Therefore if the activities of these projects encroach on a classified forest area or lead to the felling of trees outside forests, partially or fully protected, the forest service will be able to define the legal conditions for restoration and compensation for the observed losses. SENELEC may therefore, conduct its development activities throughout the territory in full harmony with the regulations in force aimed at preserving the national forest heritage for the benefit of present and future generations.

#### **ARTICLE 14: NOTIFICATIONS**

All communications or notifications under this Agreement must be made by hand, by registered letter with acknowledgment of receipt by email or fax to the following addresses:

##### **For Senelec:**

28 Vincens street BP 93 Dakar –Senegal

Attention: General Manager

E-mail:

Fax

##### **For DEFCCS:**

Parc Forestier de Hann BP 1831 Dakar,

Attention: Director

E-mail: laforetz@yahoo.fr

Fax:

**IN WITNESS WHEREOF**, the undersigned have concluded this Agreement in four (04) original copies.

Dakar JUNE 06, 2017

**SENELEC**

Mouhamadou Makhtar CISSE (signature and stamp)

General manager

**THE DIRECTION OF WATERS,**

**FORESTS AND HUNTING AND SOIL**

**CONSERVATION**

Colonel Baïdy BA (signature and stamp)

General manager

## Annex 8 - List of approved service providers for the collection and disposal of hazardous waste

**List of companies and approved EIGs for the collection and disposal of hazardous waste**

Company	Address/ Email /Telephone	Approval number	Approval Date
TOTAL	Km3, Bd du Centenaire de la Email : total@total.sn	000 1416	July 14, 2009
ECOMAR	Dakar /Pikine- highway Bountou Pikine	000 2062	May 10, 2010
DAKAR SHIPPING MULTI SERVICE	HLM Nimzat N° 2823 Dakar	000 2061	May 10, 2010
SAWA PETROLIUM SERVICE	Hydrocarbons area	000 2560	July 01, 2010
SOCOCIM	Rufisque	000 2847	August 24, 2010
SRH	Executive management Avenue Bourguiba-1,	000 2841	August 24, 2010

## **Annex 9.1 Minute of the Technical Committee**



**Thies, August 31, 2018**

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**MINISTER OF THE ENVIRONMENT  
AND SUSTAINABLE DEVELOPMENT**

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**DEPARTMENT OF ENVIRONMENT  
AND CLASSIFIED ESTABLISHMENTS**

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**REGIONAL ENVIRONMENTAL DIVISION  
AND CLASSIFIED ESTABLISHMENTS OF THIES**

**MINUTE OF MEETING OF THE TECHNICAL COMMITTEE FOR THE  
PRE-EVALUATION OF THE ENVIRONMENTAL IMPACT STUDY REPORT  
FOR THE CONTRSUTIOM AND EXPOLITATION PROJECT OF A 120 MW  
DUAL FUEL THERMAL POWER STATION IN MALICOUNDA -  
DEPARTMENT OF MBOUR**

**Introduction:**

Wednesday, August 29, 2018, was held at Thies Governance conference room, the meeting of the technical committee carrying out the in-depth impact study report (EIA) of the construction and operation project of a 120 MW dual fuel thermal power station in Malicounda, in the department of Mbour. The plant will be established on a 06 ha base; to be removed from the 18 has land allocated to SENELEC at the level of the village of Malicounda Wolof, one of the 22 localities in the Commune.

The National Electricity Company (SENELE) is the project leader, represented by Messrs. Ibrahima GUEYE and Khadim NDIAYE.

The EIA report is prepared by the Engineering Environment Services Cabinet (EES), approved by the Minister in charge of the Environment for carrying out environmental assessments in Senegal.

The meeting, presided by Mrs. Ngoné Cissé CAMARA, Deputy of the Governor in charge of Development, declared the presence of the administrative authorities concerned, in particular the prefect of Mbour and the Sub-prefect of Sindia, representatives of the technical

central services and decentralized techniques, local elected representatives, the promoter, all involved in the implementation of the project (see attendance list)

## **1. Course of the meeting**

After the welcoming and the reminder about the context of the meeting pronounced by the Governor, Mrs. Ass Tall Sarré DIANKHA, Head of the Regional Division of the Environment and Classified Establishments (DREEC) of Thies, informed about the procedure impact studies and focused on the environmental monitoring of the project in accordance with the ESMP, once the document has been validated.

Following him, Mr. Khadim NDIAYE. (Project manager at SENELEC) made some comments on the specificity and the operating principle of a combined cycle diesel thermal power station and the targeted objectives.

Mr. Abdourahme BA, Consultant of the Cabinet, avoided ESIA report in his presentation and returned to the following points:

- Context and justification of the project;
- Presentation of the project;
- Political, legal and institutional framework;
- Presentation of the receiving environment;
- Public consultation;
- Identification of impacts;
- Hazard study (EDD)
- Environmental and social management plan (ESMP)
- Surveillance and monitoring plan.

The members of the technical committee then made a number of observations which can be summed up as constants, questions and recommendations.

## **1. Observations**

### **1.1 Constant**

- The cartographic supports cannot be used;
- the property base allocated to the project is not stabilized and beyond 18 ha, the feasibility of the project is likely to be problematic;
- The plant installation site is very close to homes;
- the nearest village is less than 129 meters from the 18 ha limit;
- It will be problematic to have a buffer zone beyond the 18 ha limit;

## **Annex 9.2. Consultant responses and landing pages**

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## COMMENTS OF THE TECHNICAL COMMITTEE OF AUGUST 29, 2018 FOR THE VALIDATION OF THE EIES OF MALICOUNDA THERMAL POWER STATION

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Chapter	Recommendations/Comments	Integration and landing page
Rapport	Reread the report to correct the typing mistakes and update the data (statistics, demographic, administrative,	The report has been re-read and corrected and the data
	Give very clear and precise information on the Land estate which is required and allocated to the project	<p>SENELEC obtained the allocation of two (02) plots of respective areas; 15 ha and 03 ha. See section <b>III.4.3.1. Acquisition and land tenure security.</b></p> <p>The 18 ha correspond to the total control deliberated by Malicounda Municipal Council at the place of SENELEC. As for the 06 ha, they correspond to the area required for the construction of the central. The remaining 12 ha constitute a buffer area (safety zone with a radius of 260 m around the bins) and the green belt. The project will close the 18 ha site to secure the right-of-way.</p>
	Review document pagination	The pagination has been revised.
	Review the cover page, the Ministry of the Environment and Sustainable Development comes before the Ministry of Petroleum and Energies.	The cover page has been corrected.
	Page 11: Add the BNSP to the list of acronyms and abbreviations	The list of acronyms and abbreviations has been updated.
	Page 12: Replace MEPN by MEDD in the list of acronyms and abbreviations	The list of acronyms and abbreviations has been updated.

	Respect the hierarchy of institutions in the presentation	Respect for the hierarchy of institutions has been taken into consideration in the presentation (Cover page).
	Develop a RAP as soon as possible and compensate the People Affected by the Project (PAP)	The development of a RAP is in process. The start-up report of this PAR, already available and shared in internal, is being validated. Everyone impacted will be compensated.
	Quickly refer matters to the administrative authority for the Commission Departmental Census and Assessment of Expenses	A meeting was held for this purpose at the Prefecture of Mbour between Senelec, the Prefect of Mbour and the Cabinet EES in charge of developing the PAR in June 2018 for the start of PAR activities, for the mobilization of the Departmental Commission for Census and Assessment of Expenses.
	Provide site, ground and facility plans for the project	This recommendation is taken into account. The cards available and installation plans are integrated in the report. As for the other remaining plans, they will be prepared and deposited at the competent service level to obtain authorizations necessary for the realization of the project (construction permit, license to operate an ICPE, declaration site opening, etc.)

	Provide details to the municipality related to all technical data (especially negative impacts)	All the impacts linked to the implementation of the project have been identified in section <b>VIII.3 Identification of major impacts of the project.</b>
	Define the commitments that Senelec has made to support populations	The commitments made by Senelec to support the populations will be clearly defined during the development and execution of the RAP.
	Study the possibilities of reducing costs linked to electricity of the municipality of Malicounda	Electric power retail prices applicable by Senelec are approved by CRSE by decision N ° 2017-06 for the approval of Senelec price list applicable from 01 May 2017 and at its maximum authorized income in 2017 at the economic conditions of April 01.

		<p>The regulation of tariffs is based on the limit price of the territory and cannot be changed by Senelec</p> <p>However, the recommendation has been incorporated as improvement measure in section <b>VIII.3.3.1.2. Positive impacts during the operating phase.</b></p>
	Include in the report the protocol signed with IREF	The abstract from the protocol of both parties (SENELEC and the Department of Water and Forests) is in annex 7.3 of the report
	Specify or give PAR guarantees in the document	The development of a RAP is in process. The start-up report of this PAR, already available and shared in Internal, is being validated.
RNT	Location of the site: put the coordinates of the site	The coordinates of the site have been integrated into the section <b>III.3 Location of the project</b>
	Review the RNT to incorporate the results of the study	The RNT has been revised to better reflect the results of
	Page 14: specify the share of local labor in the construction and operation phase	The project plans to employ nearly 400 people in the phase of construction and 50 to 60 people in the phase of exploitation. The share of local labor will be determined with the local recruitment committee.
	Page 51: table 13 add another column "mode of storage of all chemicals	The recommendation has been taken into account in the table 18.
	In the project description, provide information on the technology	The proposed technology has been suggested in the

Description of the project	proposed and the quality of the fuel oil used	description of the project, see section III.4 Presentation components of the project. The characteristics of the fuel oil are given in the table 17.
	Resume the ICPE classification and provide the useful information (activities, substances, equipment) and identify the type of study required for each section.	The ICPE classification has been revised, see table 21. The promoter will also prepare a file with all elements including the list of all classified installations, products, SDS, etc. for obtaining the necessary authorizations.



	Provide sufficient information about the project needs in water	The project's water requirements were detailed in the section <b>III.4.4.3 Water consumption</b>
	Put a mini station to treat the loaded water if possible and request the services of an approved company for the sewage collection	The recommendations are taken into account in sections <b>VIII.3.1.2.2. Impacts on soil quality and water resources</b> and <b>VIII.3.3.2.2. Negative impacts on the human environment during the exploitation phase.</b>
	Make separate toilets for men and women	The recommendation has been taken into account in the section <b>VIII. 3.4. Identification of impacts on hygiene, Heath and Public Safety.</b>
	Provide watertight pits because at Malicounda the water table is not very deep	The recommendation has been taken into account in the section <b>VIII.3.1.1.2. Impacts on soils and resources waters during the construction phase.</b>
	Describe the waste management strategy	The waste management strategy has been developed in sections <b>III.4.3.7. Generation and management of waste during construction</b> and <b>III.4.4.6. Waste management during operation</b>
	Identify and evaluate the structures approved by the MEDD for the waste management	The list of structures approved for the collection and disposal of used oils is attached in annex 8.1
	Review the management of liquid effluents	

		Liquid effluent management has been treated and integrated into section <b>III.4.4.6.1. Effluent management liquids</b>
Political, legal and institutional framework		Institutional chapter, target the sector policy letter of the MEDD
	Update the references cited in the document, CDN instead of CPDN	The correction was made in table 22 section <b>IV.1.1 Political, economic and social framework in National level.</b>
	Page 65, review the section “texts relating to decentralization”	The correction was made in section <b>IV.2.1.11 Decentralization texts</b>

Description of the fired	Resume the cartographic supports and improve their readability with prints in A2 and A3 format	The cards were taken over. Location and land use maps of areas of influence have been printed in A3 format.
	Avoid touching sensitive sites (cemetery identified in	The cemetery is not located within the safety perimeter defined by the Hazard Study. However, the recommendation has been incorporated into the sub-section of Heritage cultural / historical impacts of section <b>VIII.3.3.2.2. Negative impacts on the human environment</b>
	Make a health reference situation for the project area	The health reference situation in the area was integrated as a recommendation in the ESMP and must be carried out by the plant operator.
	Get closer to the medical region for data sanitary facilities in the project intervention area	
Analysis of variants	Analyze the option of integrating the internal buffer zone 18 ha following relocation of the power plant	This option has been analyzed and it is the one chosen for the project.
	Materialize the option selected, from the analysis of variants, on a map	The selected option has been materialized on the Google image Earth 3
	Put dissemination of information instead of disclosure of	The correction was made in the chapter.

Public consultations	information at chapter 07 level	
	Respect the commitments made vis-à-vis the populations	The recommendation has been taken into account in the section <b>VII.6.2.6. CSR program.</b>
Environnemental and social Impact analysis	Take into account current projects and their rights of way (Highway)	Current projects have been taken into account in the section <b>VIII.3.5 Cumulative impacts</b>
	Make a good mapping of all interventions in the project area and take into account cumulative impacts	
	Be in charge of all project components in the impact analysis	All project components have been taken into consideration in Chapter <b>VIII. Environnemental and social Impact analysis</b>
Study of hazards	Page 182: CHEMICALS: how to chemicals: store chemicals according to their compatibility and not in bulk	The correction has been made in Table 60.

	Consider training local residents for risk management	Local residents will be made aware of the probable risks and safety measures to adopt, see section <b>IX.8.1.2 Operational resources.</b>
PGES	Develop a good communication plan for local people	The recommendation has been taken into account in the section <b>X.4.10. Information and communication to the public.</b>
	Suggest relevant strategies that make the follow-up possible	Environmental monitoring (section X.5.2) describes the measures provided by the ESMP to verify on the the accuracy of the evaluation of certain impacts and the effectiveness of certain mitigation or compensation. The monitoring elements are set out in the table 95, section <b>X.5.2. Environmental monitoring</b>
	Invite the promoter to give more importance to the communication	The recommendation has been taken into consideration in the section <b>X.4.10. Information and communication to the public.</b>

	Ensure that the development of capacities will be to all members of the monitoring committee	This recommendation is taken into account.
	Make relevant suggestions on the land estate issue	The development of a RAP is in process. The report of Start-up of this PAR, already available and shared in Internal, is being validated.
	To set up the borehole, contact the DGPRES for technical prescriptions	The recommendation has been taken into consideration in the section <b>III.4.3.3. Water consumption</b> .
	Budget the ESMP	The ESMP has been budgeted in Table 96, section <b>X.7.4. Cost estimation</b> .

## **Annex 10.1 Report of the Public Hearing**

REPORT OF THE PUBLIC HEARING FOR THE VALIDATION OF THE ENVIRONMENTAL AND SOCIAL IMPACT STUDY REPORT OF THE CONSTRUCTION AND OPERATION PROJECT OF A 120 MW THERMAL POWER STATION IN MALICOUNDA, THIES REGION.

## **Introduction**

On Wednesday October 24, 2018, the Public Hearing session was held in the public square of Malicounda municipality as part of the validation procedure for the environmental and social impact study report (ESIA) of the Construction and Operation project of a 120 MW Thermal Power station in Malicounda, (Thiès Region).

The project promoter is Malicounda Power represented by Mr. Said JALKH. It is a PPP project between Malicounda Power and the State of Senegal through the National Electricity Company (SENELEC), represented by Mr. Thierno O. KANE, Production Director.

The ESIA report is prepared by the EES Cabinet, a bureau d'Etudes approved by the Ministry of the Environment and Sustainable Development for carrying out environmental assessment missions in Senegal.

Mr. Ibrahima NDIAYE, Sub-prefect of the Arrondissement of Sindia, presided the meeting.

Took part in this meeting, the administrative and local authorities, the village chiefs, the notables, the leaders of the associative movements of women and young people of the Municipality of Malicounda, the representatives of SENELEC and of technical services which enter in the implementation of the project (see attendance list).

### **1. Course of the meeting**

After the welcome words pronounced by Mr. Maguette SENE, Mayor of the Municipality of Malicounda, the Sub-prefect recalled the context of the project, marked by Senegal's ambition to accelerate its industrialization through the Emerging Senegal Plan (PSE) and one of the essential levers of which is the establishment of a continuous and quality energy supply service at an acceptable cost to all stakeholders.

To conclude his report, the Sub-Prefect pointed out the liberation of rights-of-way, a prerogative of the State and not of SENELEC, through the Departmental Commission for Census and Assessment of Expenses under the supervision of the Prefect of the department.



Following him, Mr. Cheikhou DANSOKHO of the Directorate of Environment and Listed Establishments (DEEC) recalled the regulatory procedure that governs environmental assessments in Senegal. To this end, he mentioned, among other things, validation terms of reference for the study and the two levels of validation of the report, namely technical validation by the Interministerial Technical Committee and social and popular validation (public hearing) by local actors and populations.

Taking the floor, SENELEC, through its Operations Director, recalled the context of the justification of the project, namely to guarantee sufficient production and correct supply of energy to the country. He however specified that it is the same model of power station which is installed a little everywhere in Senegal, Tobène, Kounoune and Bel-Air etc.

In her presentation, the consultant made the restitution of the content of the ESIA report around the following aspects:

- Reminder of the context and justification of the project;
- Project display;
- Public consultation;
- Identification of the impacts of the project;
- Environmental and social management plan (ESMP);
- Surveillance and monitoring plan

Following the consultant's presentation, the promoter provided the following details to allow the assembly to better understand the outline of the project:

- The project is in line with national and international standards;
- The project uses new technology more respectful of environmental standards;
- An international firm is recruited to carry out a resettlement action plan (PAR) and the project plans to compensate all those affected by the project;
- - It will install sensors in the neighborhood of the plant for monitoring air quality in the operation phase;
- Support for communities will be guaranteed, etc.

## **2. The observations**

### **2.1. Finding**

- social acceptability and ownership of the project by the vast majority of stakeholders;
- worries about the health impacts of the project;
- worries about project pressure on water resources;
- public consultation deemed insufficient by certain actors;
- questioning of the populations on the impact of the plant on air quality;
- no start of compensation.

### **2.2. Questions**

- what are the measures taken by the project to ensure the maintenance and renewal of the generator sets in the event of aging or malfunction?
- after the transfer from Malicounda power station to Senelec, will environmental and social management still be ensured?
- is the ESIA report admissible?
- what are the security arrangements made by the promoter?
- within the framework of environmental standards, what are the most binding provisions between national texts and those of donors?

## **2. Recommendations**

- continue dialogue and consultation with stakeholders;
- respect the commitments made by Senelec and the promoter;
- support people in community development and income-generating actions;
- follow the proposed mitigation measures by involving the town hall;
- support the Municipality in its policy of building basic socio-cultural and health facilities (health, sport, education, etc.) through the signing of an agreement;
- strengthen the capacities of DEEC and CRSE to ensure correct monitoring of the ESMP;
- proceed to the inventory and compensation of PAPs;
- take all security and health measures to protect the populations of Malicounda
- 

## **3. Responses**

### **○ By the consultant**

- The worries of the population in the context of the operation of the seven generator sets at the power station will have little impact because they will be recovered and fed back into the process;
- Also, the power plant has 42 m chimneys which guarantee good dispersion of emissions;
- Within the framework of this project, the most restrictive environmental standards will be applied (national regulations or providers standards);
- The public consultation was indeed done here in the municipality of Malicounda. This consultation is documented and illustrated with images;
- The drilling that will be implemented for the project will have no impact on the supply of water to Malicounda because it will involve capturing the much deeper Maastrichtian aquifer and in extremely large quantities;

### **○ By SENELEC**

- The deterioration of the air quality by the operation of the power plant may not occur because the groups used within the framework of this project are new technologies;
- Also, with the discovery of gas in Senegal, the source of these groups will change from fuel oil to gas which is a clean fuel;
- Regarding the worries of the populations to see negligence in maintenance when the power plant is returned to Senelec after 20 years of operation, it should be noted that the technical services responsible for monitoring will not let it go;

### **○ By the Promoter**

The measures taken to guarantee good air quality include:

- Use the best fuel oil, with low sulfur content;
- Install chimneys high enough (42 m) to guarantee good dispersion of emissions (NO<sub>2</sub>, SO<sub>2</sub>, CO, PM<sub>10</sub>, PM<sub>2.5</sub>);
- Install generators of the latest generation of technology;
- Install boilers to reuse emissions in the process as much as possible;
- Install sensors for good monitoring.
- Regarding noise, double-walled walls will be installed to minimize noise pollution;
- Also we plan to use gas as fuel in the future;
- The social aspects will be treated continuously during the next 20 years during which we will operate the power station;

- Employment will be given in priority to nationals of Malicounda with equal competence;
- It is planned, with Senelec, to strengthen young graduates of the town to increase their chance of working in the plant;
- For compensation, an international cabinet is recruited to carry out the census and the evaluation in order to pay the beneficiaries and this work will start after the Magal de Touba.
- A PAR will be drawn up by this same firm.
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- **By the mayor:**
  - Respect all the commitments made within the framework of this project;
  - Indemnify the populations and support the municipality;
  - Develop and sign a tripartite agreement between the Municipality, Senelec and the promoter;
  - Set up a recruitment committee at the town hall;
  - Make a benchmarking in the other localities which shelter thermal power stations and copy the good practices here in Malicounda.

## **Conclusion**

At the end of the meeting, the populations validated by acclamation the ESIA report on the construction and operation of a 120 MW thermal power station in Malicounda.

On the basis of this Public Hearing report and that of the technical committee meeting, the ESIA report must be corrected and submitted in five copies to DEEC, in addition to the digital version in PDF for the implementation of the procedure.

According to this decision, the Sub-prefect thanked all of the participants before closing the meeting.

**The rapporteur**

Mamadou BALDE

Technical officer in the Environmental Impact Assessment Division / DEEC

## INTEGRATION OF THE COMMENTS OF THE PUBLIC HEARING OF OCTOBER 24, 2018 FOR THE VALIDATION OF THE EIES OF MALICOUNDA THERMAL POWER STATION

N°	Recommendations/Comments	Integration and landing page
1	Continue the dialogue and consultation with the stakeholders	The recommendation is taken into consideration in the section <b>VII.6.2.4. Communication and mediation around project.</b>
2	Respect the commitments made by SENELEC and the promoter	The recommendation has been taken into consideration in the section <b>VII.6.2.6. CSR program.</b>
3	Support the populations in actions of community development and income generation	These aspects will be discussed and supported as part of the memorandum of understanding to be signed between the Municipality and project company.
4	Follow the mitigation measures proposed by involving the town hall	Local authorities (town hall, local elected officials) are members of the monitoring committee. Precision is stipulated in the ESMP in section <b>X.7.1 Responsibilities.</b>
	Support the Municipality in its construction policy of socio-cultural and health facilities basics (health, sport, education, etc.) through the signing of an agreement	The CSR program declined at this stage of the project concerns the educational aspects, in particular the rehabilitation of educational establishments; and sports with the modernization of a soccer field. Others

5		activities are planned and will be formalized in the part of a tripartite agreement between Senelec, Malicounda Power and Municipality of Malicounda. The recommendation is taken into account in the section VII.6.2.6. CSR program.
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6	Build the capacities of DEEC and CRSE to ensure correct monitoring of the ESMP	The recommendation has been taken into consideration in the section <b>X.6. Capacity building plan institutional.</b>
7	Carry out a census and compensate PAPs	Developing a Resettlement Action Plan (PAR) is in progress. The startup report for this PAR is already available. All PAPs will identified and compensated.
8	Take all safety and health measures to protect the populations of Malicounda	These aspects were taken into consideration in the measurements mitigation related to hygiene impacts, Safety Environment developed in the section <b>VIII.3.4. Identification of the impacts on hygiene health and safety.</b>