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## Study and Compliance Control of Radioelectric Sites of Mobile Networks in the City of Abomey - Calavi in Benin

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**Abstract** In order to offer the widest coverage, telecom operators are constantly expanding their networks by establishing a large number of radio sites across the entire territory. This growing number of sites has made them closer to homes. These sites emit electromagnetic waves which impact the environment of residents, which raises several concerns regarding the health of local residents. Legal texts for compliance control have been established by the Beninese State to better monitor the implementation of radio sites. In these texts, limit values have been set for the intensity of the fields radiated by the different sites. As part of our work, we undertook to verify the compliance of the various radio sites installed in the town of Abomey Calavi in Benin. The compliance criteria retained are three (03): Respect of the minimum distance from homes, respect of the minimum distance from sensitive structures and finally the intensity of electric fields must be lower than the threshold of reference (6V/m). Of all the sites explored (20 in total), 100% of the sites were judged to be compliant on the three criteria. The measured electric fields vary between 10.52% and 56.54% of the threshold value set by the Beninese regulator.

**Keywords** Radio site, safety distance, radio waves, non-ionizing radiation

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### 1. Introduction/ Background

Nowadays, the demand for connectivity is quite significant among the Beninese population. This demand is due to high use of several applications requiring an internet connection. These applications include social networks, video conferencing tools, video on demand applications, etc. Added to this dependence is the need for a ubiquitous connection (in mobility). This dual need therefore obliges mobile network operators to ensure almost complete coverage of the territory and also to set up radio stations in the various urban areas of our cities and countryside. The more we desire a rapid connection, the more these radio stations are implemented alongside populations.

This proximity therefore creates a certain concern among the population regarding the impact of these stations on their health.

ARCEP Benin is the regulatory body for electronic communications in Benin. This structure carefully monitors the health of populations by putting in place standards to be respected in terms of the establishment of radio sites and also carries out several compliance control missions at the level of these different installed stations.

However, the populations are not that reassured. We therefore said to ourselves that when independent studies could carry out these checks, this would reassure the population more and if non-conformities were identified, feedback could be made to the regulatory authority.



The main objective of this study presented in this communication is to check the conformity of radio sites with the requirements for the installation of pylons.

Specifically, this involved:

- Make an inventory of standards and recommendations for the implementation of radio sites;
- Carry out a survey to identify radio sites in the city of Abomey-Calavi;
- Carry out checks and compliance measures to ensure compliance with established requirements.

As part of the compliance of radio sites, several constraints must be respected by the sites. Among these constraints, we can cite:

- A minimum distance which separates the main axis of the pylon and the immediate property whether inhabited or not;
- The minimum distance which separates the main axis of the pylon and the nearest sensitive structure (schools, nurseries, hospitals, etc.);
- The limit value set in relation to the level of exposure to the electromagnetic field of non-ionizing radiation.

The following table presents the limit values for the three constraints presented previously [1] [2].





**Table 1:** Summary of the constraints to be respected by the controlled sites

Minimum distance Pylon axis – Inhabited Property	Minimum distance Pylon axis – Sensitive structure	Limit value - level of exposure to fields
- 10 meters for pylons installed on the ground up to a height of 9 meters	100 meters	6 V/m
- 8.5 meters for pylons installed on a high point exceeding 9 meters.		

## 2. Materials and Methods

### • Hardware

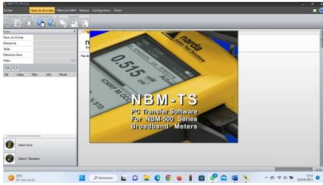

**Table 2:** List of equipment used during the study

N°	Name	Equipment image	Name equipment image use
1	NBM-550 broadband meter and its broadband isotope probe		It is a wideband field meter with data logger intended to measure electric and magnetic fields
2	GPS positioner		It is a satellite geolocation device that allowed us to find the exact coordinates of radio sites during our technical measurement work.
3	Rangefinder		It is an observation and measurement device that allowed us to know precisely how far a target is from the place from which we observe it. As part of our study, it allowed us to accurately record the distances between radio sites and homes as well as the measurement points.
4	PC		Computer on which software is installed allowing us to collect and process data from the measuring device



- **Software**

**Table 3:** List of software used

N°	Software name	Illustration	Use
1	NBM-TS		It is software used to extract measurements taken in the field by the measurer
2	Excel		The NBM-TS software exports its data in Excel format. This file is then opened in Excel by us for the compilation of the data.

- **Methodology Adopted**

The methodology adopted as part of this study is described in the following points:

- Identification of sites to study;
- Control of the conformity of the stations in relation to the distance between the sites and the immediate property inhabited or not;
- Checking the conformity of stations in relation to the distance between the sites and the nearest sensitive structure;

Monitoring the compliance of stations with respect to the level of exposure of residents to non-ionizing radiation from electromagnetic fields.

### 3. Results & Discussion

- **Identification of sites to study**

Our study was carried out in the commune of Abomey-Calavi in the Republic of Benin. To carry out the measurements, out of approximately 200 sites (base station) existing in the city of Abomey-Calavi and with the aim of ensuring better representativeness of all operational sites, a tenth or 20 sites were chosen in the framework of our study. The choice was concentrated in six (06) districts of the commune of Abomey-Calavi out of the nine (09) existing in the commune. All sites are directly located on the ground. The following table presents the different sites covered by this study.

**Table 4:** Geographical positions of the sites studied

N°	Districts	Villages/city neighborhoods	Longitudes (°)	Latitudes (°)
1	ABOMEY-CALAVI	Aïdégnon	2,329944	6,45525
2	ABOMEY-CALAVI	Aïfa-Calavi	2,329511	6,461584
3	ABOMEY-CALAVI	Aïtchédji	2,341194	6,456556
4	ABOMEY-CALAVI	Alédjo	2,332748	6,443051
5	GODOMEY	Cité-la-Victoire	2,329321	6,412551
6	ABOMEY-CALAVI	Cité-la-Victoire	2,336709	6,418549
7	ABOMEY-CALAVI	Fandji	2,351043	6,468849
8	ABOMEY-CALAVI	Finafa	2,335639	6,432556
9	KPANROUN	Kpanroun	2,363402	6,672311
10	ABOMEY-CALAVI	Kansounkpa	2,317196	6,498411
11	AKASSATO	Agassa-Godomey	2,369303	6,53725
12	VEKKY	Totakoun	2,408684	6,472123
13	GODOMEY	Djoukpa-Togoudo	2,333824	6,406292
14	ABOMEY-CALAVI	Tchinangbégo	2,347443	6,431244



15	GODOMEY	Fignonhou	2,335133	6,379721
16	TOGBA	Ahossougbeta	2,31965	6,46659
17	ABOMEY-CALAVI	Tchinangbegbo	2,34942807	6,43651153
18	ABOMEY-CALAVI	Tokpa-Zoungo-Sud	2,346147	6,413801
19	TOGBA	Tankpe-Tanme	2,3024	6,4269
20	AKASSATO	Akassato	2,366215	6,506298

The following figure shows the geographical distribution of these different sites on a map.

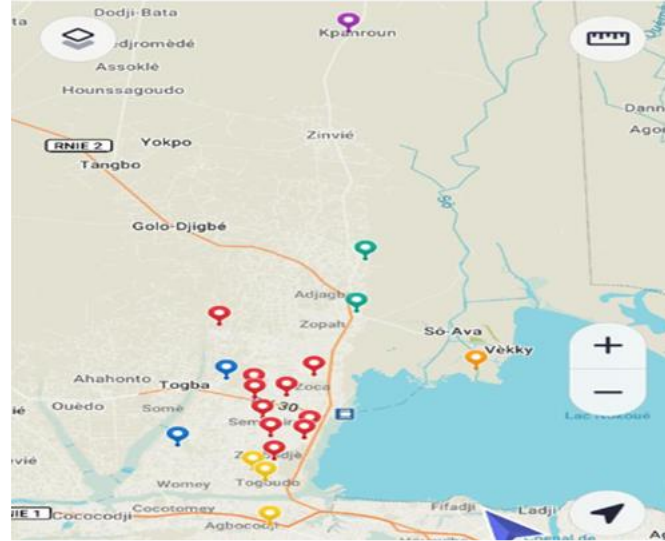


Figure 1: View on a map of the sites studied

- **Control of the conformity of the stations in relation to the distance between the sites and the immediate property inhabited or not**

Here we will just present the information collected for the site closest to a property and for the site furthest from a property.

- Closest site to a property

This is site N°4 in Table 4.

Geographic coordinates of the site	Coordinates of the property immediately near the site	Distance between site and property in meters
Longitude : 2,332748 Latitude : 6,443051	Longitude : 2,332801 Latitude : 6,442941	13,58

The closest site to a property is therefore 13.58 meters from the latter

- Farthest site from a property

This is site N°1 in Table 4.

Geographic coordinates of the site	Coordinates of the property immediately near the site	Distance between site and property in meters
Longitude : 2,329944 Latitude : 6,45525	Longitude : 2,330071 Latitude : 6,45574	56.33

The farthest site from a property is therefore 56.33 meters from the latter.

The measures taken in relation to the security perimeters in our case study revealed that the radio sites studied respect the distances set by the regulatory authority. As a reminder, the minimum distance is 8.5 meters and the site with the closest property is located 13.58 meters away. We therefore deduce that the different sites comply with the regulations on this criterion.



- **Checking the conformity of stations in relation to the distance between the sites and the nearest sensitive structure**

Here, we will just present the information collected for the site closest to a sensitive structure and for the site farthest from a sensitive structure.

- Site closest to a sensitive structure

This is site N°1 in [Table 4](#).

Geographic coordinates of the site	Kindergarten contact details	Distance between site and sensitive structure in (m)
Longitude: 2,329944 Latitude: 6,45525	Longitude: 2,330162 Latitude: 6,453922)	149,79

The closest site to a sensitive structure is therefore 149.79 from the latter.

- Farthest site from a sensitive structure

This is site N°1 in [Table 4](#).

Geographic coordinates of the site	Contact details for the el-rapha Clinic	Distance between site and sensitive structure in (m)
Longitude: 2,341194 Latitude: 6,456556	Longitude: 2,341172 Latitude: 6,460026	386,29

The farthest site from a sensitive structure is therefore 386.29 from the latter. The regulations in force tell us that any installation of a radio site must respect a minimum distance of one hundred (100) meters from sensitive structures. Thus the results from our study allowed us to identify distances greater than those required by the regulator. Based on this fact, according to our comparative study, it appears that the radio sites chosen are therefore in compliance with this factor.

- **Monitoring of station compliance with electric field measurements**

The various equipment presented was used to evaluate the exposure of the population around the sites studied. Here we will present the information collected for the site with the highest radiation and the site with the lowest radiation.

- Site with the greatest radiation

This is site N°4 in [Table 4](#).

Measurement date/time	Measured field level (v/m)			Overall value
	110cm	150cm	170cm	
17/04/2023 13:05:09	3,576208	3,216791	3,392981	3,398496

- Site with the least radiation

Measurement date/time	Measured field level (v/m)			Overall value
	110cm	150cm	170cm	
25/04/2023 09:30:21	0,661819	0,635576	0,595409	0,631525

The limit value not to be exceeded in the regulations is 6V/m. At the end of the various measurements, all the sites studied were judged to comply with the regulations.

Based on the evaluation of the conformity of the sites in relation to homes (sensitive structures) and the analysis of the security perimeter, we noted from our study that the radioelectric sites chosen are in conformity from the point of view of distance per in relation to the decisions set by the regulator. Furthermore, based on the evaluation of the twenty measurement points selected to study the level of exposure of the inhabitants of the town of Calavi, we found that the electric field evaluated at these points varies between 10.52% and 56.64 % around the reference limit value (6 V/m). The values of the electric fields measured being lower than the threshold set, we can therefore conclude that the limit values for exposure to RNI are respected.



#### 4. Conclusion

In conclusion, this work allowed us to control the compliance of several radio sites in the city of Abomey-Calavi. Three criteria were assessed: The security perimeter, The distance between the axis of the radio site and the nearest sensitive structure and finally the measurement of the electric field. On all the sites visited, all complied with the regulations in force in the Republic of Benin. We therefore recommend that this study be extended to all sites in order to have exhaustive results that can truly reassure the population.

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