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EARTHING SYSTEM IN AFIKPO METROPOLIS: ITS IMPACTS ON DOMESTIC INSTALLATIONS

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ABSTRACT

This paper presents the EarthingSystem in Afikpo Metropolis: Its Impacts on Domestic Installations. This research is to ensure safe use of electric energy by providing information on the earthing system within Afikpo and its environs. Survey was carried out in different areas ofAfikpo metropolis by carrying out practical investigation using earth resistance tester to ascertain the various earth resistance properties of the areas.However the result from this research work revealed that less attention has been paid to preliminary test of the soil before earthing in most of the domestic installations thus resulting in various fault conditions in the installations. This research work provides required data on the resistance properties of various areas in Afikpo metropolis (AkanuIbiam Federal Polytechnic Unwana, Unwana town, EnohiaItim town,Ozizza town, Ehugbo town, Ndibe town and Amasiri town) a metropolitan town in EbonyiState, Nigeria. It is also believed to have enough information that will help in reducing the rampant cases of poor earthing practices with its attendant hazards.

Keywords: Afikpo Metropolis, Earthing, Resistance, Earth Electrode, Earth Resistance, Earthing system, Domestic Installations.

INTRODUCTION

The environment under study is AfikpoMetropolis which comprises AkanuIbiam Federal Polytechnic Unwana, Ehugbo town, Unwana town, EnohiaItim town,Ozizza town, Ndibe town, Amasiri town, etc. This research work takes a look at the connection of the non-conductingconductorin an electrical installation or facility to the general mass of the earth by creating a low resistance path for the flow of fault current using earth electrode as a first link.This reduces the degree of opposition to the flow of fault current. The assembly ofearth electrode and earth continuity conductor in a particular soil portion around an electrical installation in order to provide a low resistance path for fault current describes an earthing system (Rajput, 2011). The simplest and somewhat misleading idea of a good ground for an electrical system is a section of iron pipe driven into the earth with a wire conductor connected from the pipe to the electrical circuit.However, this may, or may not be a suitable low resistance path for electric current to protect personnel and equipment. The reason is that earth resistivity has an important bearing on electrode resistance as does the depth, size and shape of the electrode. In a simple way, electrodes are conducting elements used in conveying current to and from the medium under study, which is the earth in this case (Uppal and Garg, 2009).

RELATED THEORIES

Many important works have been done on earth resistance testing. According to Robert andWilliam (1987),a reliable equipment grounding system that connects all the metallic frames of electrical equipment together must be kept at a safe reference potential. They also stated that the most reliable and accurate method for determining the earth electrode resistance was identified as the "fall-of-potential" method, stressing that the resistance of a ground bed cannot be accurately measured unless it is isolated from other parallel ground paths. The current generated by a test instrument will be split among all the paths. As such, the meter reading on a test instrument will not represent the ground bed resistance accurately.Megger (2010), a registered trademark in the manufacturing of test instruments in her Getting Down to Earth, A Practical Guide to Earth Resistance Testing, made it clear that the resistivity of the earth depends much on:

- The type of the soil;
- Moisture content;
- Availability of dissolved salts;
- Variation in climatic conditions and
- The resultant effects on the temperature of the soil.

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Owing to this fact, any reliable earth resistance test must consider the influence of these variables on the resistivity of the soil specimen under test.
Another important parameter in an effective and efficient earthing system is the earth electrode. The earth electrode is the means of making contact with the general mass of the earth. The Electrician Guide to the 16th Edition IEE Regulations opines that major considerations should be made to ensure that the electrode resistance is not so high that the voltage from the earthed metalwork to the earth exceeds 50V (IEE, 2001). In cases where Residual Current Devices are used, the product of the operating current of the Residual Current Devices in amperes and the electrode resistance in ohms should not exceed 50V for normal dry locations or25V for construction sites and agricultural premises. Based on the above fact, due consideration should be given to earth electrode resistance to ensure conformity to the above standard. Efforts should be made to ensure that earth resistance does not exceed 200 Ohms, for a proper earthing to be achieved in a domestic installation (Rao, 2009a).El-Tous and Alkhawaldeh (2014) posited that using chemical elements around the electrode of earthing systems reduces the earth resistance and as such improves the efficiency of the system.They however noted that the use of these elements cannot guarantee very high reduction in earth resistance accompanied by their expensive nature and unavailability at all times, hence their stand for the use of Dead Sea Water instead of the chemical elements to further reduce the earth resistance at minimum cost. The measurement of resistance for an earth electrode is very important and as such, should be done when the electrode is first installed and then at periodic intervals thereafter. This is meant to ensure that the resistance-to-ground does not increase over time (Rao, 2009b). Again, Rao (2009b) further advocated the use of ground resistance monitoring system which acts as an automated timed/continuousresistance to ground measurement, explaining that this dedicated system uses the induced frequency test method to continuously monitor the performance of critical grounding systems.Some models may also provide automated data reporting without interrupting the electrical services.
The domestic installations in Afikpo metropolis are faced with earthing challenges because the rural dwellers do not have access to the requisite testing before earthing. This is basically due to lack of the needed expertise on the part of the local artisans and the cost and availability of earth resistance measuring equipment. This study is geared towards giving builders and house owners an idea of how to get their buildings earthed in Afikpo metropolis; thereby answering the technical complaints that have always emanated from the artisans.

CRITICAL LONG RUN FACTORS TO CONSIDER

Results have revealed that the following factors do affect minimum earth resistance:
Changes in the Size of Electrical Facility: A plant or other electrical facility can expand in size. Also, new plants continue to be built larger. Such changes create different needs in the earth electrode. What was formerly a suitably low earth resistance can become an obsolete standard.
Increase in the Use of Digital Technology: As facilities add more modern sensitive computer-controlled equipment, the problem of electrical noise is magnified. Noise that would not affect cruder, older equipment can cause daily problems with problems with new equipment.
High Presence of Non-metallic Materials in the Earth: As more non-metallic pipes and conduits are installed underground, such installations become less dependable as effective, low-resistance ground connections.

METHODOLOGY

This study involved serious field work. The towns in question were physically visited and the earth resistance measurement was actually taken. In each town, two different spots were tested. One spot was usually the top of a hilly place and it is referred to, in this paper as 'High Spot'. The other is the base of a valley which is here referred to as 'Low Spot'. The essence of this was to see if the altitude of the soil has any effect on the resistance of the earth of a particular place. Therefore two readings were obtained from each town. Again, at each spot, four readings were taken to ensure repeatability. At the end, the average of the four readings was taken.
It is worthy of mention, that the instrument used was Megger Earth Resistance Tester. It is an analogue measuring instrument with three different values of multipliers to make readings easier.
The earth electrode used was a 4-feet copper electrode. This means that the measurements were done from a depth of 4 feet. This was considered more reliable than using the 2-feet electrode.

Figure 1 below is a schematic diagram of the actual connections made at the spots where the resistances were taken.

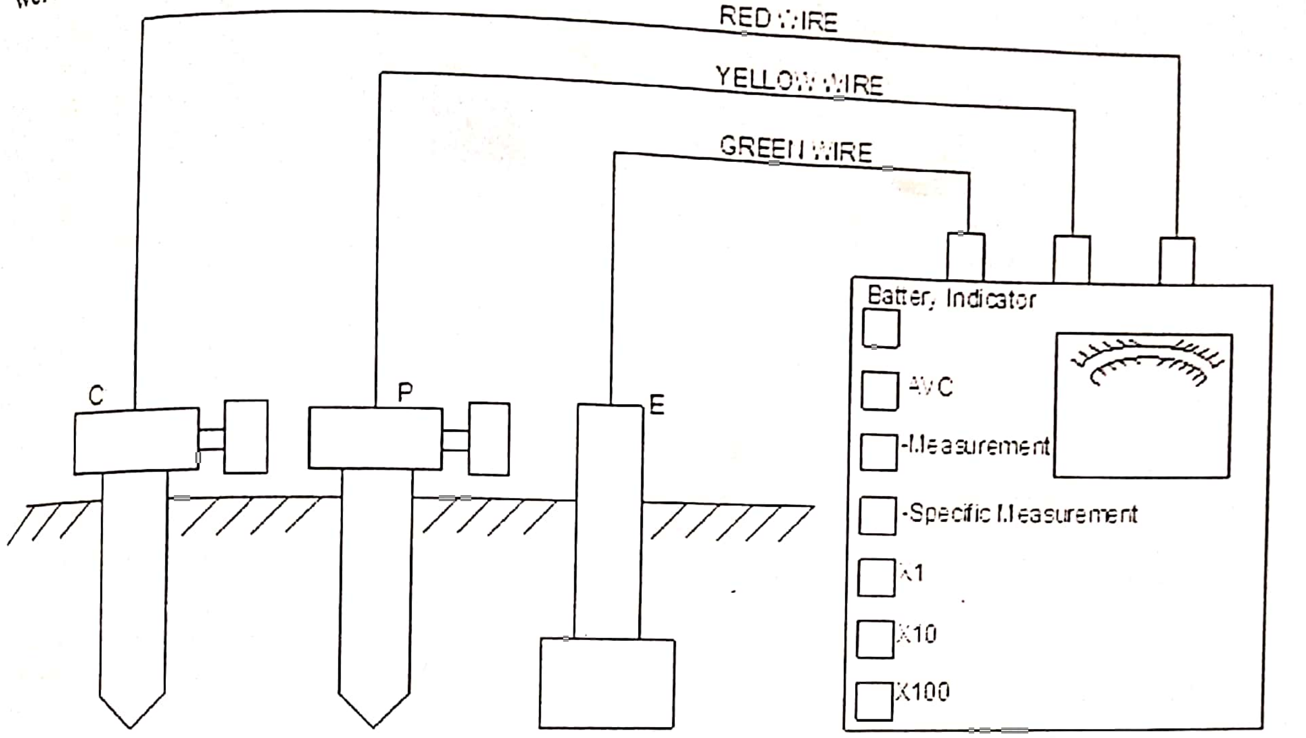

Figure 1: Schematic diagram of the earth resistance measurement

E is earth electrode; P is a steel pin while C is another steel pin. By specification, E, P and C are required to be separated from each other by between 5 metres to 10 metres. Measurement is taken by selecting a multiplier and pressing the 'Measurement' button.

Procedure

The procedure observed in carrying out the study at each study spot was as follows:

- The C electrode was driven into the earth and connected to the instrument.
- The P electrode was driven into the earth and connected to the instrument.
- The E electrode was driven into the earth and connected to the instrument.
- Each of the electrodes was 5 to 10 metres apart of the other.
- The connection of the probes was crosschecked to ensure accuracy.
- The battery indicator key was pressed to ensure that the instrument is working properly.
- The appropriate multiplier was selected for each soil composition.
- The measurement button was pressed to obtain a reading and it was taken three times while the average was recorded as shown in table 1.

RESULTS

Table 1: Towns and their earth resistance readings

S/N	Locations	Readings(Ω)	
		High Spot	Low Spot
1	Federal PolytechnicUnwana	560	350
2	Unwana town	1010	350
3	Amasiri town	577	522
4	Ozizza town	363	920
5	Ehugbo town	960	560
6	Ndibe town	1100	1
7	Enohialtim town	1005	200

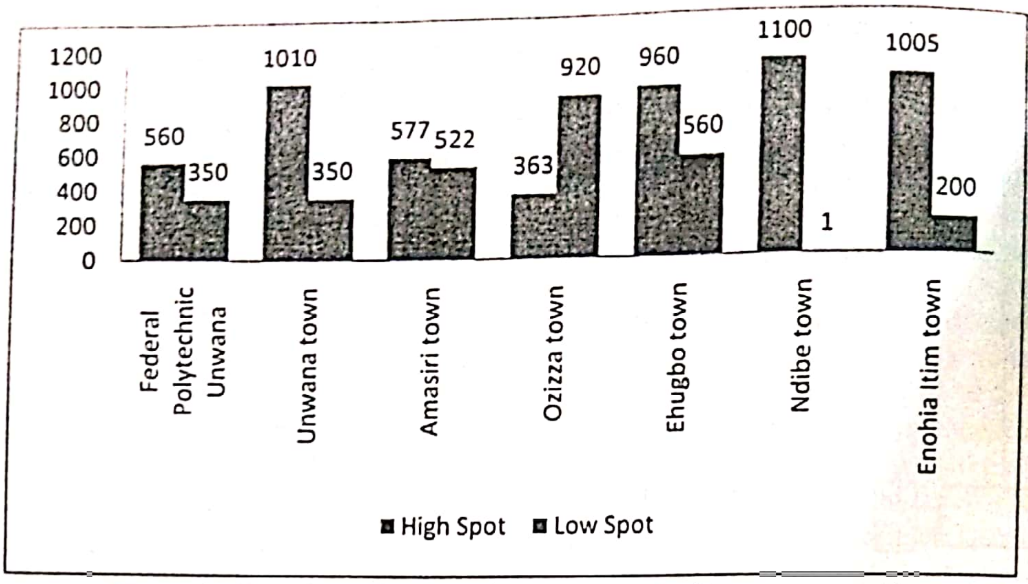

Figure 2: Bar chart of earth resistance values in Afikpo metropolis

DISCUSSION

It should be recalled that (Rao, 2009a) advised that efforts should be made to ensure that earth resistance does not exceed 200Ω, for a proper earthing to be achieved in a domestic installation. However, looking at table 1 above, five out of the seven towns that were studied, recorded earth resistances of over 200Ω at both their high and low spots. These towns include Ehugbo town, Ozizza town, Amasiri town, Unwana town and Federal Polytechnic Unwana.Ndibe town recorded the highest resistance at the high spot (1100Ω) and the lowest resistance at the low spot (1Ω). It is worthy to state here, that the valley area that was tested at Ndibe town, had a water logging nature and a bed rock in the soil that could not allow the earth electrode to go up to half of its length into the soil. This is suspected to be the reason behind the very low reading of only 1Ω. The low spot of EnohiaItim town was the only area that recorded the maximum acceptable 200Ω.Ozizza town rather sprang a surprise by giving a higher resistance reading at the low spot. It is 920Ω for the low spot and 363Ω for the high spot. To explain the likely cause of this scenario, recall what Meggar(2010) posited in her Getting Down to Earth, A Practical Guide to Earth Resistance Testing – thatthe resistivity of the earth depends much on:

- The type of the soil;
- Moisture content;
- Availability of dissolved salts;
- Variation in climatic conditions and
- The resultant effects on the temperature of the soil.

It is very possible that one or more of the above factors must have contributed to that result.

RECOMMENDATIONS

- Appropriate regulatory body such as COREN should periodically organize an enlightenment campaign for artisans, craftsmen and technicians to ensure due compliance with normal earthing standards.
- There should be periodic testing of already existing electrical installations to ensure that variation in the resistivity of the earth does not adversely affect the effectiveness of the earthing system.
- Certifying bodies should put-up a frame work that will ensure that intending artisans, technicians, etc. are made to be owners of relevant earth testing kits before certification.
- Regulatory body such as COREN is encouraged to ensure pretesting of completed domestic installation before they are put to use.

CONCLUSION

By the foregoing observations therefore, the safe professional advice that can be given to members of these towns is that they need to treat their soil very well during earthing. This is more serious for those whose buildings are located at high spots.The aim of this treatment is to reduce the resistance of the earth at that spot to less than or equal to 200Ω. El-Tous and Alkhawaldeh (2014) suggested the use of chemical compounds (e.g. aqueous methacrylamide, sodium acrylate, etc.) around the electrode of earthing systems.

However, they noted that the use of these elements cannot guarantee very high reduction in earth resistance accompanied by their expensive nature and unavailability at all times. They later suggested the use of Dead Sea Water instead of the chemical elements to further reduce the earth resistance at minimum cost. Others suggested the use of salt. For instance, Okyere and Eduful (2006) suggested the use of two or more earth electrode buried at different locations and connected in parallel: addition of salts such as magnesium sulphate, sodium chloride, copper sulphate, etc. and use of soil of lower resistivity as an earth electrode backfill. Moreover, the advice is that whatever method that is employed, there should be a regular check on the resistivity of the area in use to ensure that it is treated when necessary to avoid an undesirable increase in the earth resistance.

REFERENCES

El-Tous, Y. and Alkhawaldeh, S.A.(2014). An Efficient Method for Earth Resistance Reduction Using the Dead Sea Water. Energy and Power Engineering, pp. 6-47-53 .http://dx.doi.org/10.4236/epe.2014.64006

IEE, (2001).IEE Wiring Regulations.Sixteenth Edition.USA. [Online] https://www.iz3mez.it/wpcontent/library/ebook/16th%20Ed%20IEE%20Wiring%20Regulations%20%5B3%20books%5D%20%20B.%20Scaddan%20%282001%29%20WW.pdf. Retrieved on May28, 2015.

Megger, (2010).Getting Down to Earth.Dol: 1-866-254-0962.www.megger.com Retrieved on March 5, 2015.

Okyere, P. Y. and Eduful, G. (2006).Reducing Earth Electrode Resistance by Replacing Soil in Critical Resistance Area.The International Journal of Modern Engineering, 6(2).

Rajput, R. K. (2011). Electrical and Electronic Measurements and Instrumentation. Second Edition (Reprinted); S. Chand & Company Ltd, New Delhi, India.

Roa, S. (2009a). Testing Commissioning Operation and Maintenance of Electrical Equipment. Sixth Edition (Ninth Reprinted), Khanna Delhi, India.

Roa, S. S. (2009b). Switchgear Protection and Power Systems (Theory, Praactice and Solved Problems). Thirteenth Edition (Reprinted). Khanna Publishers, Delhi, India.

Robert, L.C and William, J.H (1987) Ground Resistance Testing in the Mining Industry. Conference proceeding from: Annual Technical Conference of the International Testing Association.[Online]: http://www.msha.gov/s&hinfo/techrpt/ground/groundre.htm . Retrieved on March 19, 2015.

Uppal, S. L. and Garg, G. C. (2009).Electrical Wiring Estimating and Costing.Sixth Edition, Khanna Publishers, NaiSarak Delhi, India.

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