Reliability Evaluation of 11/0.415kv Substations A Case Study of Substations in Ede Town

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***Abstract* - This paper presents the results of reliability evaluation of 11/0.415 substations in Ede town (Osun State, Nigeria). Accurate data on 11/0.415kV substations does not exist but there is daily record of complains of outages by customers with date, identified fault and the substations affected. From this record, outage duration, outage frequency and the number of customers affected were estimated based on the time and nature of the fault. These data were used to evaluate reliability indices of each 11/0.415kV substations. The results show that out of the 29 substations under assessment, only all customers on three (*Rinsayo, INEC, Winner*) substations experience significant stable power availability for months. There was improved reliability for customers on *St. Anthony, Sabo and NITEL* substations. For others substations, it was either there is no specifics trend of reliability performance or the power reliability was getting worse. The results also show that different customers experience different levels of reliability and availability of supply even if they are under the same feeder and/or substation.**

Keywords: Availability, Feeder, Reliability, Reliability Indices, Substation

I. INTRODUCTION

Reliability is a key factor in power system design, planning and operation, particularly for substation. Substations are use for raising voltage level for transmission and stepping down for power distribution. Substation consists of power transformer, feeder pillars; switching, measurement, protection and control devices to ensure safe and efficient operation.

11/0.415kV substations are common sight on streets and perform the function of distributing and coordinating power supply to specific group of consumers in a given neighborhood. 11/0.415kV substation is the final stage of electric power distribution system in Nigeria, as the circuits leaves the substation at 240/415V to enter consumers' terminals. Much of the outages at distribution level occur at this final stage [1]. Therefore, ensuring a very reliable substation at this final stage of power distribution is a very important issue.

Substations play key role in reliability of any electric power systems. At distribution level, it is use in dividing long power lines into smaller sections. This helps to reduce any interruption to the continuity of supply when a section is not functional or faulty or during maintenance work. By knowing how to calculate the reliability of different substation configurations, an engineer can use this information to help design a system with the best overall reliability. But determining the reliability of a substation can also be important for existing installations as it can help locate weak points that may be contributing to overall system unreliability [2].

Reliability engineering has both quantitative and qualitative aspects; measurements of reliability are necessary. However measuring reliability does not make a product reliable, only by designing-in reliability, can a product achieve its reliability targets. By identifying possible causes of failure and elimination will obviously help to improve product reliability [3].

Most power outages are caused by storm and weather-related damage to overhead distribution power lines. Heavy winds and storm can cause trees to touch power lines, contact of two phases and sometimes can cause lines, poles to break and fall. Animal contact (snake, lizard, bird), overloading, vehicular accidents, equipment failure, and human error also contribute to cause of power outages [4]. Aging of equipment and installation; and use of substandard cables/materials are other factor affecting reliability of power distribution systems.

II. RELIABILITY DEFINITIONS

Reliability is a very broad concept and multiple of definitions abound in many literatures. In Engineering, Reliability is commonly defined as the probability that an item will perform a required function without failure under stated condition for a stated period of time.

In EPRI White Paper [5], the authors pointed out that Reliability cannot be discussed apart from the objectives of the system. The goals of the power distribution system are identified as:

(i) covering the territory (an aspect of adequacy),
(ii) having sufficient capacity for peak demand (another aspect of adequacy),
(iii) being able to operate under adverse conditions (security), and
(iv) providing a stable voltage (quality).

The definitions of reliability in the literature address some common aspects of electric power systems. These include continuity of service, meeting customer demands, and the vulnerability of the power system. Reliability concerns are often split into three categories:

Adequacy, or the capacity and energy to meet demand, which is the ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements. System adequacy relates to the existence of sufficient generation, transmission and distribution facilities within the system to satisfy the customer load demand [6].

Security, or the ability to withstand disturbances, that is the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements; and

Quality, or acceptable frequency, voltage and harmonic characteristics

The North American Reliability Council [7], define Reliability as the degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards and in the amount desired.

Reliability of power distribution system may be described or measured by outage duration, the time required to restore supply, the frequency of the outage and the numbers of customers affected as well as the magnitude of adverse effects on the electric supply.

III. RELIABILITY EVALUATION

Reliability analysis is a vital tool for critical identification of sensitive components of electric power systems that needs more attention for better improvement and at the same time to increase the system availability [8]. There are indices that are in use for measuring or evaluating reliability of power distribution system. The indices require existing data of interruption frequency, outage duration, number of affected consumers. Some of the indices are:

(i) System Average Interruption Duration Index (SAIDI). It is a measure of duration. It measure the number of minutes/hours over a period of time (day, month or year) that the average customer is without power. It is given by

$$SAIDI = \frac{\sum Ni * d}{Nt} \quad (1)$$

$$= \frac{\text{Summation of Customer-hour}}{\text{Total number of registered customer}} \quad (2)$$

Where

N_i is the number customer affected by the outage

N_t is the total number of registered customer, and

d is the duration of the outage

(ii) Customer Average Interruption Duration Index (CAIDI). It is also a measure of time. CAIDI is the average time needed to restore service to the average customer per sustained interruption. It is given by the sum of customer interruption durations divided by the total number of customer interrupted.

$$CAIDI = \frac{\sum Ni * d}{Ni} \quad (3)$$

$$= \frac{\text{Summation of Customer-hour}}{\text{Total number of customer interrupted}} \quad (4)$$

(iii) System Average Interruption Frequency Index (SAIFI). SAIFI is a measure of numbers of times (frequency) . SAIFI is the average number of time that a consumer experiences an interruption of supply in a given period of time (day, month or year). SAIFI is dimensionless

$$SAIFI = \frac{\sum Ni}{Nt} \quad (5)$$

$$= \frac{\text{Total Number of customers interrupted}}{\text{Total number of registered customer}} \quad (6)$$

(iv) Average System Availability Index (ASAI). It is the same as System Reliability Index SRI. It is a measure of the overall reliability of the system. It represents the percentage of time during the year (8760hours) or month (720hours) or day (24hours) that the average customer has power supply.

$$ASAI = 100[1 - (\sum Ni \times d) / (Nt \times T))]$$

$$\text{ASAI} = 100 \left(1 - \frac{\sum (N_i x d)}{N_t x T}\right) \quad (8)$$

Where T is the period under investigation

In this work, these four indices are use to quantify and evaluate the reliability of power substation in Ede town.

IV. RESEARCH METHODOLOGY

Reliability analysis uses either qualitative or quantitative techniques. Qualitative techniques imply that reliability assessment must depend solely upon engineering experience and judgment. Quantitative methodologies use statistical (involve data collection) approaches to reinforce engineering judgments. Quantitative techniques describe the historical performance of existing systems and utilize the historical performance to predict the effects of changing conditions on system performance [9]. In this research, quantitative techniques combined with theoretical methods are used to evaluate the distribution system reliability.

After receiving official permission from Ibadan Electricity Distribution Company (IBEDC)

The following data were collected from the company:

1. Numbers of feeders (33, 11kV)
2. Numbers of 11/0.415 substations
3. Numbers of outages on each feeders
4. Duration of each outages
5. Causes of outages
6. Number of consumers on each feeder
7. Number of consumers on every circuit on each transformer/substation
8. Equipment in the reserve (transformer, feeder pillar, fuse, pole, overhead cables etc)
9. Age of distribution equipment/item

Accurate data on fault, outages, causes of outages, duration of outage exist on 33 and 11kV feeders exist. However, similar data on 415kV does not exist but there is daily record of complains of outages by customers with date, identified fault and the substations affected. A rough estimate of outage duration was gotten from the time the complain was lodged plus the average time it takes to clear fault plus five hours (assumed time it takes before customer complains). There was also timetable for everyday load shedding which the staff. Shedding of load on some substations was carried out every day. This is to safeguard the substations' transformers from failure due to overloading.

The number of customers affected was deduced from numbers of metering unit on affected substation transformer. The nature of fault also determines the number of customer affected. For instance, a single phase off (single-phasing) on the secondary side of transformer will definitely affect one-third of the total customers on the substation. Similarly, a phase off on a 415V upriser circuit affects one-third of the customers on the circuit which may be one-sixth of customer on the substation if it has two circuits or around one-ninth population of customers on the substation if it has three circuits. After getting the estimated values, reliability indices like SAIDI, CAIDI, SAIFI and ASAI was use to estimate the reliability of each of 29 substations supplied by the major 11kV township feeder.

V. ANALYSIS AND DISCUSSION OF RESULT

Table 1 gives the name of substations, the substation capacity, the station's transformer voltage ratio, the numbers of circuits (i.e. the numbers of three-phase circuit that emanate from feeder pillar), the substations' customer population, and the date fault occurred. The seventh column is the numbers of customers affected by the fault, followed by estimated outage duration (in hours) of each fault and then the customer-hour on the last column, which is a summation of the product of numbers of affected customers and outage duration in hour.

Table 1: Substations and outage data for the month of March

MARCH								
Substation Name	Transformer Capacity	Volt Ratio	Number of Circuits	Customer Population	Date of Fault	Number of Affected Customers	Duration (hour)	Customer Hours
Wuraola	500KVA	11/0.415 KV	3	259	17	86	6	516
St Anthony	500KVA	11/0.415 KV	3	265	4,11 Everyday LS	2(88) + 88*31= 2904	2(6)+ 14*31=446	39248
LevelCrossing	500KVA	11/0.415 KV	3	227	12,19,24	3(76) = 228	3(6)=18	1368
Poly Junction	500KVA	11/0.415 KV	3	260	14,16	2(87) = 174	8+6=14	1218
440 Adejare	500KVA	11/0.415 KV	3	208	5,14,15,24,24,26,27	6(69)+208 = 622	6(6)+8=44	4148
Alusekere	500KVA	11/0.415 KV	3	300	14,22	2(100) = 200	2(6)=12	1200
Deeper Life	500KVA	11/0.415 KV	3	230	10	77	6	462
Apaso	500KVA	11/0.415 KV	2	303	15,18,21	3(100) = 303	3(6)=18	1800
CAC	500KVA	11/0.415 KV	2	150	11,14,15,18,23,24 ,25,26,27	7(50)+2(100) =550	7(6)+2(8)=58	3700
Olukolo	500KVA	11/0.415 KV	2	220	-	-	-	-
Obada	500KVA	11/0.415 KV	2	125	14,21,27	2(63) + 125 = 188	2(6)+24=36	3756
Palace	500KVA	11/0.415 KV	3	363	9,14,19,22,25,26,30	6(121)+ 363 = 1089	6(6)+6=42	6534
Olaiya	500KVA	11/0.415 KV	3	250	12,24	2(83) = 166	2(6)=12	996
Akewula	500KVA	11/0.415KV	3	250	23, 27	2(250)= 500	6 + 24 = 30	7500
Apena	500KVA	11/0.41KV	2	249	-	-	-	-
INEC	500KVA	11/0.415 KV	3	125	8	125	6	750
Winners	300KVA	11/0.415 KV	3	120	-	-	-	-
Adogbe	300KVA	11/0.415 KV	2	234	1	78	6	468
Sabo	300KVA	11/0.415 KV	3	210	4,5,18,19,31 Everyday LS	5(70) = 350 +70*31= 2520	5(6)=30 +14*31= 464	32480
Rinsayo	300KVA	11/0.415 KV	3	95	-			

						-	-	-
Sawmill	300KVA	11/0.415 KV	2	350	23	117	6	702
Agbale II	300KVA	11/0.415 KV	2	50	-	-	-	-
Ojoro	300KVA	11/0.415 KV	3	127	24	43	6	256
Agate/Asawo	300KVA	11/0.415 KV	3	244	28,31	82+244 = 326	6+6=12	1956
NITEL	300KVA	11/0.415 KV	3	256	4,11,19,22,23,25,27,30 Everyday LS	8(86) = 688 +128*31= 4656	8(6) = 48 +14*31= 482	59680
Agbale I	300KVA	11/0.415 KV	2	105	11,20,25,26	3(35) +105 = 210	3(6)+6=24	1260
ElerinJunction	200KVA	11/0.415 KV	2	135	24,24,25 Everyday LS	2(45)+ 135=225 +67*31 = 2302	2(6)+6=18 +14*31= 452	30428
Camp Young	200KVA	11/0.415 KV	4	100	17	34	6	204
Iso Isu	300KVA	11/0.415 KV	3	460	10,12,28,29 Everyday LS	3(153)+ 460 = 919 +153*31 = 5662	3(6)+8=26 +14*31= 460	72836

The last three columns are bit technical. Taking *Iso-Isu* substation as an example (the last row), fault occurs on 10th, 12th, 28th and 29th of the month of March. Three of the four faults affected one-third of the customer population (153) because one phase of the transformer' secondary side went off.

The fourth fault affected the entire substation population. At this substation, there was everyday load shedding because the total customers' load is higher than the transformer' capacity. So one of the three circuits had to be switched off at peak load duration of 6pm to 8am, a period of 14 hours. At other period of the day, all the circuits are on because the transformer can conveniently accommodate the load.

From the explanation above, the total customer affected by the four outages experience at this substation for this month is (3 × 153 + 460) = 919. This is apart from those affected by load shedding which is 153 customers everyday for 31 days in the month. This gives 4743 customers. So the total customers affected by outages for the month of March is (919 + 4743) = 5662 customers.

Still on *Iso-Isu* substation, each of the three outages last for average of 6hours which gives 18hours outage. The fourth outage last for 8hours. The outage duration due to shedding of load is (14hours × 31days) = 434 hours. So the total outage duration for the months is 18 + 8 + 434 = 460 hours. For the customer-hour on the seventh column, it is
(153 × 6) + (153 × 6) + (153 × 6) + (153 × 6) + (460 × 8) + 31(153 × 14) = 72836.

$$SAIDI = \frac{\sum Ni*d}{Nt}$$

$$= \frac{\text{Summation of Customer-hour}}{\text{Total number of registered customer}}$$

$$SAIDI = \frac{72836}{460} = 158.34\text{hours}$$

So the total outage duration for average customer on this substation for the month of March is 158.34hours.

$$CAIDI = \frac{\sum Ni*d}{Ni}$$

$$= \frac{\text{Summation of Customer-hour}}{\text{Total number of customer interrupted}}$$

$$= \frac{72836}{5662} = 12.86 \text{ hours}$$

This means that on the average, it takes 12.86hour to restore supply once there is supply. In other words, outage last for 12.86hour on the average for the month of March for customers on this substation.

$$SAIFI = \frac{\sum Ni}{Nt}$$

$$= \frac{\text{Total Number of customers interrupted}}{\text{Total number of registered customer}}$$

$$= \frac{5662}{460} = 12.31 \text{ times}$$

This is the number of outages experienced by customers on this substation.

$$ASAI = 100\left(1 - \frac{\sum(N_i x d)}{N_t x T}\right)$$

$$= 100\left(1 - \frac{72836}{460 x 744}\right) = 78.72\%$$

This is the percent of the time supply is available to average customer in the month.

Other substations reliability indices are similarly analysed and obtained for the month of March. This was done covering twelve month periods from March 2014 to February 2015 and the result tabulated in Table 2 to 5. The tables also show the monthly average of the reliability on the last column.

Tables 2 gives the monthly outage duration in hours for customers on each substation. Table 3 shows the average duration of each outage, i.e. the average time it took to restore supply each time there is power failure. Table 4 provides the number of times outage occurred for every month. Table 5 presents percentage availability of supply of each substation for each month.

Customers on *Elerin Junction* substation suffer unavailability of supply most. The customers experienced outage for 197 to 225 hours every month for the period of one year under the study. *Iso Isu* is another substation badly affected with average of 149 hours of outage every month. This was due to shedding of load experienced at these two substations. *Sabo* and *St. Anthony* substations also experienced shedding of load from March to August; and *NITEL* substation from March to October.

Rinsayo is the substation that enjoys regular supply most. For the first 11 months, the customers on the substation did not experience any outage. *Winners, INEC, Apena, Agbale II, Adogbe, Apena and Poly Junction* are among the substations with better availability of supply.

Customers on *Rinsayo* substation had no outage until February and it took 6hours to restore supply which translate to 30minute monthly average for the whole year. The station had the highest percentage availability.

It should be noted that though the table 2 to 5 give the reliability performance of the substations fed by 11kV township feeder, it is not however, the true everyday reality of the substation. This is because happenings at generation, transmission, at 33 and 11kV feeders further impact reliability of power at the substations. While the reliability evaluation of the entire power system is an important requirement in overall power system planning and operation, it is not usually conducted on a complete power system due to its complexity [6]. Rather, the reliability evaluation of each subsystem is usually conducted independently. This kind of analysis generally assumes that the other parts of the system are fully reliable and capable of performing their intended functions [10].

VI. CONCLUSION AND RECOMMENDATION

The information presented in this paper is reflection of the 11/0.415 kV substations' reliability at Ede town, covering a period from March 2014 to February 2015. The findings will also provide IBEDC the state of reliability of each substation; this should facilitate proper monitoring, maintenance and upgrade of substations.

While more substations should be planned for, in the meantime, the IBEDC can divert some load on substations subjected to power rotation (due to outage during peak periods) to nearby substations that can accommodate such load.

A proper detail data and record of each substation should be kept by utility company in respect to outage duration, outage frequency as well as record of component/equipment failure. The author had serious challenges in getting these data during the course of this research simply because it is not being kept.

A standard way of reporting fault and outages at the consumers end should be devised rather than the method of individual customer coming to utility office to complain. This method will never give accurate time the fault or the outage occurs. The electric service provider should employ modern and better technology (intelligent monitoring device) to achieve this [11].
Equipment and materials needed for maintenance should readily be available. Electric poles, fuse, jumper wires, distribution cables, cross-arm and others materials should be available in store. It is good for at least two or three spare transformers to be available at every business district. A situation where the community has to provide these when needed prolong down time which affect reliability

Immediate response by technical staff to clear fault is highly recommended as this will significantly reduce down time. It is also important to adequately remunerate electricity staff, particularly those in technical department of repairs and maintenance. Their condition of service should be improved. Good compensation in case of any hazard should be ensured.

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REFERENCES

[1] H.A Boknam, S. Park, C. Shin, S. Kwon and S. Park, "Power Quality Monitoring on Distribution Network using Distribution Automation System'', 19th International Conference on Electricity Distribution Vienna, Paper 0426, 2007.

[2] Daniel Nack, "Reliability of Substation Configurations" Iowa State University, 2005

[3] Warwick Manufacturing. "Introduction to Reliability Engineering." University of Warwick 2007

[4] US Department of Energy, "Electricity Delivery and Energy Reliability." Smart Grid Investment Programme 2012 www.smartgrid.gov accessed on 4 March 2015

[5] Electric Power Research Institute's White Paper (EPRI) "Reliability of Electric Utility Distribution Systems", Palo Alto, CA: 1000424. 2000

[6] Popoola J., Ponnle A.., Ale T. "Reliability Worth Assessment of Electric Power Utility in Nigeria: Residential Customer Survey Results" School of Electrical and Information Engineering, University of Witwatersrand Johannesburg, South Africa, 2011

[7] North American Electric Reliability Council (NERC),"Long-Term Reliability Assessment." September 2004. Available at http://www.nerc.com/~filez/rasreports.html

[8] Adefarati T., Babarinde A., Oluwole S. and Oluseyi K. Reliabilty Evaluation of Ayede 330/132kV Substation, International Journal of Engineering and Innovative Technology Vol 4 Issue 4 October 2014

[9] Dan Zhu Power System Reliability Analysis with Distributed Generators, MSc Thesis, Department of Electrical Engineering, Virginia Polytechnic Institute and State University, 2003

[10] Y ang, F. 2007. "A Comprehensive Approach for Bulk Power System Reliability Assessment." PhD Thesis, Georgia Institute of Technology, Atlanta, Georgia, USA, March, 2007 Available at: http://etd.gatech.edu/theses/available/etd- 04012007-205524/unrestricted/yang_fang_ 200705phd.pdf>.

[11] Komolafe O.A. and Akinwumi A.O. 2014. "Intelligent Monitoring of Substation to Improve Distribution Network Reliability," Department of Electronic and Electrical, Engineering, Obafemi Awolowo University, Ile- Ife, Nigeria

Table 2: Twelve Months SAIDI (outage duration hr) of all the Substations (Mar. 2014-Feb.2015)

Substation Name	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
Wuraola	1.99	0.00	3.98	3.98	3.98	0.00	7.97	15.96	3.98	19.95	7.97	9.99	6.65
St Anthony	148.11	1.39	150.10	139.47	146.11	149.49	0	0	0	0	3.98	0	61.55
Level Crossing	6.03	0.00	8.01	6.19	4.02	10.32	8.04	16.04	20.05	20.04	34.04	2.05	11.24
Poly Junction	4.68	2.01	0	2.01	0	0	1.80	2.01	0	6.06	4.02	0	1.88
440 Adejare	19.94	1.21	23.94	14.13	6.06	7.96	16	3.98	7.96	5.77	18.10	7.66	11.06
Alusekere	4.00	4.67	20.00	6.00	6.00	2.00	4	14	2	0	4.00	18	7.06
Deeper Life	2.01	6.03	2.01	0	0	8.01	16.02	12.03	12.03	6.03	16.03	26. 11	8.86
Apaso	5.94	4.00	10.00	6.00	4.00	12.00	12	9.01	0.00	2.00	2.00	20	7.25
CAC	24.67	2.00	6.00	6.00	4.00	18.00	18	16	4	30.00	40.00	20	15.72
Olukolo	0	0	11.98	2.02	7.99	8.02	5.97	0	0	3.98	0	4.01	3.66
Obada	30.05	0	16.08	0	4.03	2.02	8.02	2.02	6.05	2.02	21.03	13.04	8.70
Palace	18.00	0	4.00	6.05	6.00	2.00	22	2	6	2.00	14.00	4	7.34
Olaiya	3.98	4.03	5.98	8.02	9.96	0	0	1.99	0	2.02	5.98	2.02	3.67
Akewula	30.00	4.03	29.98	10.20	7.97	6.00	9.96	3. 98	3.98	2.02	19.97	23.97	12.84
Apena	0	2.00	8.00	2.02	12.00	0	4	10	4	4.00	0	0	3.84
INEC	6.00	0	0	0	0	0	12.05	8.02	0	0	0	0	2.17
Winners	0	0	0	0	6.00	4.00	6	0	12	2.00	0	10	3.33
Adogbe	2.00	6.00	0	0	0	2.00	20	0	2	6.00	0	22	5.00
Sabo	154.67	142	164.67	144.00	148.67	146.67	6	4	2	6.00	6.00	4	77.39
Rinsayo	0	0	0	0	0	0	0	0	0	0	0	6	0.50
Sawmill	2.01	0	4.01	2.01	86.4	2.01	1.95	8.01	2.01	12.03	2.01	2.01	10.37
Agbale II	0	0	6.00	2.04	0	2.04	2.04	6.12	0	6.00	6.12	6	3.03
Ojoro	2.02	0	16.25	2.03	2.03	3.97	17.92	7.94	5.95	7.94	3.97	5.97	6.34
Agate/Asawo	8.02	8.07	2.02	0.00	5.98	0	2.02	11.98	1.99	9.96	9.96	13.99	6.17
NITEL	233.13	220.08	219.02	212.02	222.98	228.95	219.96	231.11	210	4.03	13.98	3.98	168.27
Agbale I	12.00	0	8.00	0.00	7.94	16.00	22	10	8	10.00	16.00	22	10.16
Elerin Junction	225.39	212.44	225.39	212.44	221.03	215.39	208.44	218.61	211.56	218.61	218.61	197.45	215.45
Camp Young	2.04	0	8.16	2.04	4.08	10.50	0	2.04	0	3.96	13.94	2.04	4.07
Iso Isu	158.34	142.62	147.97	144.63	151.32	150.34	140.61	147.30	146.63	167.32	145.30	146.88	149.11

Table 3 Twelve Months CAIDI of all the Substations (Mar. 2014-Feb.2015)

CAIDI	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
Substation Name													
Wuraola	6.00	14.00	6.00	6.79	5.93	13.75	6	6	6	6.67	6.00	7.5	7.55
St Anthony	13.52		13.29	14.00	13.75	6	-	0	-	-	6.00	-	5.56
Level Crossing	6.00	6.00	6.00	6.00	5.85		6	6.85	6.66	6.00	7.28	6	5.22
Poly Junction	7.00	6.00	-	6.00	-	6	6	6	-	6.00	6.00	-	4.08
440 Adejare	6.67	7.00	6.00	6.00	6.00	6	8	6	6	6.00	6.75	2.88	6.10
Alusekere	6.00	6.00	7.50	6.00	6.00	6	4	7	6	-	6.00	6	5.54
Deeper Life	6.00	6.00	6.00	-	-		6	6	6.04	6.00	6.86	39	7.33
Apaso	5.94	6.00	6.00	6.00	6.00	6	6	6	-	5.99	6.00	6	5.49
CAC	6.73		6.00	6.00	6.00	6	6	6	6	6.43	7.06	6.67	5.74
Olukolo			7.20	6.00	6.00	6	6	0	-	6.00	0.00	6	3.60
Obada	19.98		6.00	-	6.00	6		6	6	6.00	12.58	7.09	6.30
Palace	6.00	6.00	6.00	6.00	6.00		7.33	6	6	6.00	7.00	6	5.69
Olaiya	6.00	6.00	6.00	6.00	6.00	6		6	-	6.00	6.00	6	5.00
Akewula	15.00	6.00	10.01	6.00	5.93		6	6	6	6.00	6.00	9.01	81.95
Apena			6.00	6.00	6.00		6	6	6	6.00	-	-	3.50
INEC	6.00		-	-	-	6	6	6	-	-	-	-	2.00
Winners		6.00	-	-	6.00	6	6	0	6	6.00	0.00	7.50	3.63
Adogbe	6.00	13.74	-	-	-	13.75	6	0	6	6.00	0.00	6	4.79
Sabo	12.89		12.35	13.50	13.52		6	6	6	6.00	6.00	6	7.36
Rinsayo			-	-	-	6		-	-	-	-	6	1.00
Sawmill	6.00		6.00	6.00	43.14	6	6	6	6	6.00	6.00	6	8.60
Agbale II			6.00	6.00	-	6	6	6	-	6.00	6.00	6	4.00
Ojoro	5.95	6.00	6.00	6.00	6.00		6.75	5.86	6	6.00	6.00	6	5.55
Agate/Asawo	6.00	13.19	6.00	-	5.93	13.09	6	6	6	6.00	6.00	10. 50	7.06
NITEL	12.82		13.83	13.82	13.51	9.33	13.20	12.95	14	6.00	7.00	6	10.21
Agbale I	6.00	13.66	6.00	-	6.00	14	6	7.5	6	7.50	6.00	6	6.55
Elerin Junction	13.22		13.48	13.66	12.87	6	14	14	14	14.00	14.00	14	11.94
Camp Young	6.00	13.74	6.00	6.00	2.43	13.29		6	-	6.00	7.01	6	6.04
Iso Isu	12.86	14.00	13.81	13.50	13.29	13.75	14	13.75	13.27	12.50	14.00	12.38	13.34

Table 4: Twelve Months SAIFI of all the Substations (Mar. 2014-Feb.2015)

SAIFI	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
Substation Name													
Wuraola	0.33	9.96	0.66	0.57	0.67	10.62	1.33	2.66	0.66	2.99	1.33	1.33	2.76
St Anthony	10.96	-	11.29	9.96	10.63	2.01	-	0	-	-	0.66	-	3.79
Level Crossing	1.00	3.34	1.34	1.03	0.69		1.34	2.34	3.01	3.34	4.67	2.01	2.01
Poly Junction	0.67	2.01	-	0.33	-	1.33	0.30	0.33	-	0.81	0.67	-	0.54
440 Adejare	2.99	6.67	4.00	2.36	1.01	0.33	2	0.66	1.33	0.96	2.68	2.66	2.30
Alusekere	0.67	1.00	2.67	1.00	1.00	1.34	1	2	0.33	-	0.67	3	1.22
Deeper Life	0.33	6.67	0.34	-	-	2.00	2.67	2.00	1.99	1.00	2.34	0.67	1.67
Apaso	1.00	0.33	1.67	1.00	0.67	3.00	2	1.50	-	0.33	0.33	3.33	1.01
CAC	3.67		1.00	1.00	0.67	1.34	3	2.67	0.67	4.67	5.67	3	1.09
Olukolo	0.00		1.66	0.34	1.33	0.34	0.99	0	-	0.66	0.00	0.67	0.5
Obada	1.50		2.68	-	0.67	0.33	1.34	0.34	1.01	0.34	1.67	1.84	0.98
Palace	3.00	0.67	0.67	1.01	1.00		3	0.33	1	0.33	2.00	0.67	1.14
Olaiya	0.66	0.67	1.00	1.34	1.66	1.00		0.33	-	0.34	0.99	0.34	0.69
Akewula	2.00	0.33	3.00	1.70	1.34		1.66	0.66	0.66	0.34	3.33	2.66	1.47
Apena	0.00		1.33	0.34	2.00		0.67	1.67	0.67	0.67	-	-	0.61
INEC	1.00		-	-	-	0.67	2.01	1.34	-	-	-	-	0.42
Winners	0.00	1.00	-	-	1.00	0.33	1	0	2	0.33	-	1.33	0.42
Adogbe	0.33	10.33	-	-	-	10.67	3.33	0	0.33	1.00	-	3.67	2.47
Sabo	12.00		13.33	10.67	11.00		1	0.67	0.33	1.00	1.00	0.67	4.31
Rinsayo	0.00		-	-	-	0.33		0	-	-	-	1	0.11
Sawmill	0.33		0.67	0.33	2.00	0.34	0.33	1.33	0.33	2.01	0.33	0.33	0.69
Agbale II	0.00		1.00	0.34	-	0.66	0.34	1.02	-	1.00	1.02	1	0.53
Ojoro	0.34	1.34	2.71	0.34	0.34		2.65	1.35	0.99	1.32	0.66	0.99	1.09
Agate/Asawo	1.34	16.67	0.34	-	1.01	17.49	0.34	1.20	0.33	1.66	1.66	1.33	3.61
NITEL	18.19		15.84	15.34	16.51	1.71	16.66	17.85	15	0.67	1.99	0.66	10.04
Agbale I	2.00	15.55	1.33	-	1.32	15.39	3.67	1.33	1.33	1.33	2.67	3.67	4.13
Elerin Junction	17.05		16.72	15.56	17.05	1.75	14.89	15.61	15.11	15.61	15.61	14. 10	13.26
Camp Young	0.34	10.37	1.36	0.34	1.68	11.31		0.34	-	0.66	1.99	0.34	2.39
Iso Isu	12.31	9.96	10.71	10.71	11.38	10.62	10.04	10.71	11.05	13.38	10.38	12.38	11.14

Table 5: Twelve Months ASAI of all the Substation (Mar. 2014-Feb.2015)

ASAI	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
Substation Name													
Wuraola	99.73	100	99.47	99.45	99.47	100	98.89	97.85	99.45	97.32	98.93	98.51	99.09
St Anthony	80.09	99.81	79.81	80.63	80.36	79.91	100	100	100	100.00	99.47	100	91.37
Level Crossing	99.19	100	98.92	99.14	99.46	98.61	98.88	97.84	97.22	97.31	95.42	99.69	98.47
Poly Junction	99.37	72.20	100	99.72	100.00	100	99.75	99.73	100	99.19	99.46	100	97.45
440 Adejare	97.32	99.83	96.78	98.03	99.13	98.93	97.78	99.47	98.89	99.22	97.57	98.86	98.48
Alusekere	99.46	9.93	97.31	99.16	99.19	99.73	99.44	98.12	99.72	100.00	99.46	97.32	91.57
Deeper Life	99.73	0.01	99.73	100	100	98.92	97.78	98.38	98.33	99.19	97.85	96. 14	98.84
Apaso	99.20	99.44	98.66	99.16	99.46	98.39	98.33	98.79	100	99.73	99.73	97.02	98.99
CAC	96.68	99.72	99.19	99.16	99.46	97.58	97.50	97.85	99.44	95.97	94.62	97.02	97.85
Olukolo	100.00	100	98.39	99.50	98.93	98.92	99.17	100	100	99.47	100	99.40	99.48
Obada	95.96	100	97.84	100.00	99.46	99.73	98.89	99.73	99.16	99.73	97.17	98. 06	98.81
Palace	97.58	100	99.46	99.16	99.19	99.73	96.94	99.73	99.17	99.73	98.12	99.40	99.02
Olaiya	99.46	99.44	99.20	98.89	98.66	100	100	99.73	100	99.73	99.20	99.69	91.17
Akewula	95.97	99.44	95.97	98.58	98.95	99.19	98.62	99.47	99.45	99.73	97.32	96.43	98.26
Apena	100.00	99.72	98.93	99.50	98.39	100	99.44	98.66	99.44	99.46	100	100	99.46
INEC	99.19	100	100	100	100.00	100	98.33	98.92	100	100.00	100	100	99.70
Winners	100.00	100	100	100	99.19	99.46	99.12	100	98.33	99.73	100	98. 50	99.53
Adogbe	99.73	99.16	100	100	100.00	99.73	97.22	100	99.72	99.19	100	96.73	99.29
Sabo	79.21	80.27	77.87	80.00	80.02	80.29	99.12	99.46	99.72	99.19	99.19	99.40	89.48
Rinsayo	100	100	100	100.00	100	100	100	100	100	100.00	100	99. 11	99.93
Sawmill	99.73	100	99.46	99.72	88.39	99.73	99.73	98.92	99.72	98.35	99.73	99.70	98.60
Agbale II	100.00	100	99.19	99.72	100.00	99.73	99.72	99.18	100	99.19	99.18	99. 11	99.57
Ojoro	99.73	100	97.82	99.72	99.73	99.73	97.51	98.93	99.17	98.93	99.47	99. 11	99.15
Agate/Asawo	98.92	98.87	99.73	100.00	99.20	100	99.72	98.39	99.72	98.66	98.66	97.92	90.82
NITEL	68.67	69.43	70.56	70.55	70.03	69.23	69.45	68.94	70.83	99.46	98.12	99.4	77.06
Agbale I	98.39	100	98.93	100.00	98.93	97.85	96.94	98.66	98.89	98.66	97.85	96.73	98.49
Elerin Junction	69.71	70.49	69.71	70.49	70.29	71.05	71.05	70.62	70.62	70.62	70.62	70.62	70.49
Camp Young	99.73	100	98.90	99.71	99.45	98.59	100	99.73	100	99.47	98.13	99.69	99.45
Iso Isu	78.72	80.19	80.11	79.91	79.66	79.79	80.47	80.20	79.63	77.51	80.47	78.4	79.59