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Some operations of electric power supply system in Benin City area of Nigeria

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ABSTRACT

The Power Holding Company of Nigeria (PHCN) is responsible for generating, transmitting, distributing and selling electric power to the various consumers throughout the country. The paper presents the results of an investigation conducted on some of the operations of Power Holding Company of Nigeria (PHCN) to determine some of the major factors affecting the availability of power supply to consumers in Benin City area of Nigeria. The average number of operating transformers in various substations and their percentage loadings were also studied. It was discovered that the average power supply to Government Reservation Area (GRA) was more regular and stable than that of Siluko area of Benin City.

Keywords: Electric Power, Major Factors, Operating Transformers, Percentage Loading.

INTRODUCTION

Electric power supply is the most important commodity for national development. With electrical energy the people are empowered to work from the domestic level and the cottage industries, through the small-scale and medium industries to employment in the large-scale manufacturing complexes. In these days, depriving people of electric power is tantamount to castration. According to Musa (2007). electric power generation may be through one of the following sources of energy: coal, oil or natural gas, hydro power (water turbine), nuclear power (steam turbine), solar-wind or water-wave turbine, solar thermal generator, solar voltaic generator. Coal, oil, gas and hydro power are abundant in Nigeria. Presently Nigeria mostly employs gas-fired and hydroelectric turbines for bulk generation, oil being too expensive and coal-fired stations having gone moribund, Musa (2007). Maximum power consumption or peak demand depends on the population and industrialization of a country. If the maximum supply meets the peak demand, there is a surplus otherwise there is a shortfall. Supply, demand and losses are related by the following equation, Musa (2007):

Supply – Demand = Supply – Actual needs – Losses = Surplus, and

Losses = Heat losses + Wastages + Diversions

However, in Nigeria, the power supply system is run with a shortfall where demand exceeds supply.

The Power Holding Company of Nigeria (PHCN) is responsible for generating, transmitting, distributing and selling electric power to the various consumers throughout the country. A major objective of PHCN, naturally has been to provide regular and an uninterrupted power supply to the consumers of electricity nationwide. However, Benin City, one of PHCN's main distribution areas in Edo State has suffered a great deal of irregular power supply in the last few decades. A number of authors have studied power supply systems and various aspects of their operations (Lequeux, 1980; Kurzyn, 1981; Becker, 1981; Rahman, 1981). However, very few have investigated and documented in learned journals the counterpart of the system in Nigeria. Manafe (1979) studied the establishment and the growth of electricity in Nigeria. He found that the various stage of electricity development in Nigeria had been under the following controlling Authorities: The Public Works Department (PWD), The Nigeria Electricity Supply Co-operation (NESCO), The African Timber and Plywood Limited (AT&P), The Electricity Co-operation of Nigeria (ECN), The Niger Dams Authority (NDA) and the National Electric Power Authority (NEPA).

The capacity in Kilowatt generated by each of the generating units in various parts of the country has also been studied (Oyeyele, 1987). That work also examined the Nigerian electricity market and found that the annual growth rate of electricity sales averaged about 18 percent in the period of 1950/52 to 1976/77. It concluded, in part, that Nigeria still has a low electricity consumption of 60 KWH/Capita (1979 figures), which is less than 1 percent of that of industrialized countries. It was discovered that developing countries like Liberia, Ivory Coast and

Guinea have per capital electricity of about ten times, four times and two times respectively than that of Nigeria. The work, however, pointed out that the low consumption capita in Nigeria is due to the fact that over 80 percent of the population normally reside in the rural areas where they have no access to electricity as well as low level of industrialization. The Public Relations Department (PRD) of PHCN has reported that there was a rapid expansion in electrical energy transmission in the period 1960 – 1985. The solar and wind energy resource in Nigeria has also been studied (Sambo, 1987). The author found that the annual mean of solar energy received in Nigeria is 2, 300Kwh per meter squared and global radiation is as high as 24MJ per meter squared per day due to its good geographical location between latitude 4 degree and 14 degree north of the equator. Anazia, in 1990 considered the preventive maintenance and diagnostic testing intervals for electrical equipment in a cement factory in Nigeria.

Nigeria's public power company-Power Holding Company of Nigeria has an installed generating capacity of about 6GW but actual available output is less than 2.5GW. Power black-out is frequent. New generation capacity-build-up under the National Integrated Power Project (NIPP) would result in more than 10GW by 2010. Available public capacity is supplemented by private captive generation serving industrial clusters and specific companies in the Cement, Steel and Oil & Gas sectors of the economy. A set of newly licensed independent power producers (IPP) would add more than 10GW if all come on stream before 2010-2012, (Olivia, 2008).

On the whole, the literature on power distribution in Nigeria is rather scanty and to the best of authors' knowledge, it appears that very little work, if any, has been done in assessing the reliability of power supply. In particular, we could find no published work that dealt with the factors responsible for the reliability of power supply to consumers in Benin City; the present work which is an attempt to fill this gap is a follow up on an earlier one (Odior, 2005).

Major feeders and injection substations in Benin City: There are essentially five major feeders from transmission to all the injection substations in Benin City. These feeders transmit electric power supply to the various injection substations. The location and capacity of each of these feeders as well as the attached injection substations are presented in Table 1.

Table 1: **Major Feeders and Attached Injection Substations**

Location	Capacity	Attached Injection Substation
Benin Feeder I	30 MVA	G.R.A. and Nekpenekpen
Benin Feeder II	30 MVA	Guinness, Federal Housing Estate, Ugbowo, UNIBEN and Okada Village.
Sapele/ Koko Feeder	30 MVA	Ologbo, Oghare and Koko.
Etete feeder	60MVA	Etete I and Etete II.
Ikpoba Dam Feeder	60MVA	Siluko and Ikpoba Dam.

The Power Holding Company of Nigeria (PHCN) formerly known as National Electric Power Authority (NEPA) has established and is implementing guidelines for the percentage loading of any power transformer based on the following criteria: the load reading on the power transformer, and the rating in ampere on the secondary side of the transformer. The rating in ampere on the secondary side of the transformers commonly used in power distribution are typified by Table 2 and the estimation of the percentage loading for each period depends on the rating in ampere on the secondary side of the particular transformer concerned.

Table 2: Rating of Injection Substations.

Injection Substation	Capacity of Transformer MVA	Voltage KV	Transformer's Rating on the Secondary Side (AMPS)
GRA S/S TXI	7.5	33/6.6	650
SILUKO S/S TXI	7.5	33/11	394
SILUKO S/S TXII	7.5	33/11	394

Electric power outages : Electric power outages occur frequently in Benin City and some of the factors responsible for such outages were also studied for a period of five months for Siluko and GRA injection substations. A summary of the results is presented in Table 3. It is observed that GRA is more under control than the Siluko injection substation.

Table 3: Major Factors for Electric Power Outages

Factors	Numbers of Outages		Total	Percentage
	SILUKO	GRA		
Man – Made	64	28	92	40.9
Earth fault	40	15	55	24.4
Over current	19	15	34	15.1
Natural fault	15	12	27	12.0
Transient fault	12	5	17	7.6

Table 4: Mean Daily Peak Load Readings for GRA Injection Substation

Day	Time (Hrs)	Rating in KVA	Voltage KV	Peak Load Readings in AMPS			Percentage loading (%)
				R	Y	B	
1	20.00	7, 500	33/11	340	340	340	75
2	19.30	7, 500	33/11	357	357	357	61
3	22.30	,,	,,	330	330	330	64
4	20.00	,,	,,	380	380	380	76
5	21.00	,,	,,	350	350	350	69
6	20.00	,,	,,	350	350	350	69
7	19.30	,,	,,	370	370	370	74
8	19.30	,,	,,	300	300	300	76
9	19.30	,,	,,	340	340	340	76
10	20.00	,,	,,	384	384	384	67
11	21.30	,,	,,	360	360	360	81
12	20.00	,,	,,	370	370	370	84
13	19.30	,,	,,	360	360	360	81
14	19.00	,,	,,	340	340	340	66
15	22.00	,,	,,	340	340	340	76
16	19.30	,,	,,	380	380	380	76
17	19.30	,,	,,	386	386	386	76
18	21.30	,,	,,	330	330	330	68
19	20.00	,,	,,	358	358	358	71
20	19.00	,,	,,	380	380	380	76
21	21.30	,,	,,	320	320	320	71
22	23.00	,,	,,	320	320	320	71
23	20.30	,,	,,	380	380	380	66
24	19.30	,,	,,	370	370	370	64
25	19.30	,,	,,	380	380	380	66
26	19.30	,,	,,	360	360	360	71
27	22.00	,,	,,	380	380	380	76
28	19.30	,,	,,	380	380	380	76
29	22.30	,,	,,	320	320	320	71
30	23.00	,,	,,	350	350	350	69
31	19.30	,,	,,	380	380	380	66

Table 5: Mean Daily Peak Load Readings for Siluko Injection Substation (T x 1)

Day	Time (Hrs)	Rating in KVA	Voltage KV	Peak Load Readings in AMPS			Percentage loading (%)
				R	Y	B	
1	21.00	7, 500	33/11	310	310	310	79
2	20.30	7, 500	33/11	350	350	350	89
3	21.30	,,	,,	380	380	380	99
4	20.30	,,	,,	320	320	320	80
5	22.30	,,	,,	300	300	300	76
6	20.00	,,	,,	350	350	350	89
7	22.00	,,	,,	340	340	340	86
8	20.00	,,	,,	340	340	340	86
9	20.30	,,	,,	350	350	350	89
10	20.30	,,	,,	350	350	350	89
11	19.30	,,	,,	380	380	380	96
12	20.00	,,	,,	370	370	370	94
13	19.30	,,	,,	350	350	350	89
14	22.30	,,	,,	310	310	310	79
15	19.30	,,	,,	350	350	350	89
16	19.00	,,	,,	380	380	380	96
17	20.30	,,	,,	390	390	390	97
18	19.30	,,	,,	380	380	380	96
19	19.30	,,	,,	360	360	360	91
20	19.30	,,	,,	90	90	90	23
21	19.00	,,	,,	350	350	350	89
22	19.30	,,	,,	370	370	370	94
23	19.30	,,	,,	370	370	370	94
24	20.00	,,	,,	380	380	380	96
25	19.30	,,	,,	350	350	350	89
26	21.30	,,	,,	350	350	350	89
27	20.00	,,	,,	350	350	350	89
28	20.00	,,	,,	370	370	370	94
29	20.00	,,	,,	360	360	360	94
30	19.00	,,	,,	90	90	90	23
31	20.00	,,	,,	270	270	270	61

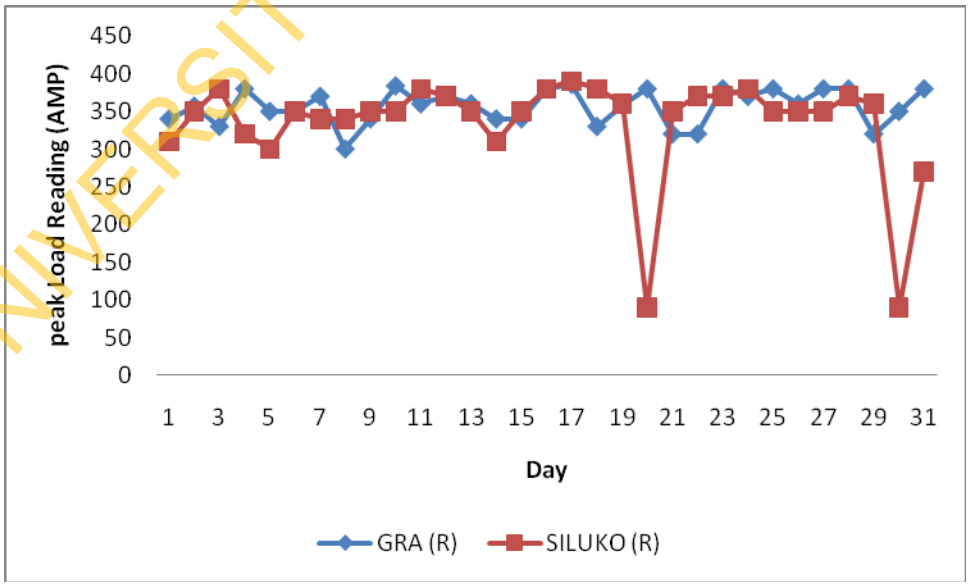

Fig. 1: Mean Daily Peak Load Readings for GRA and Siluko Injection Substations (Red Phase).

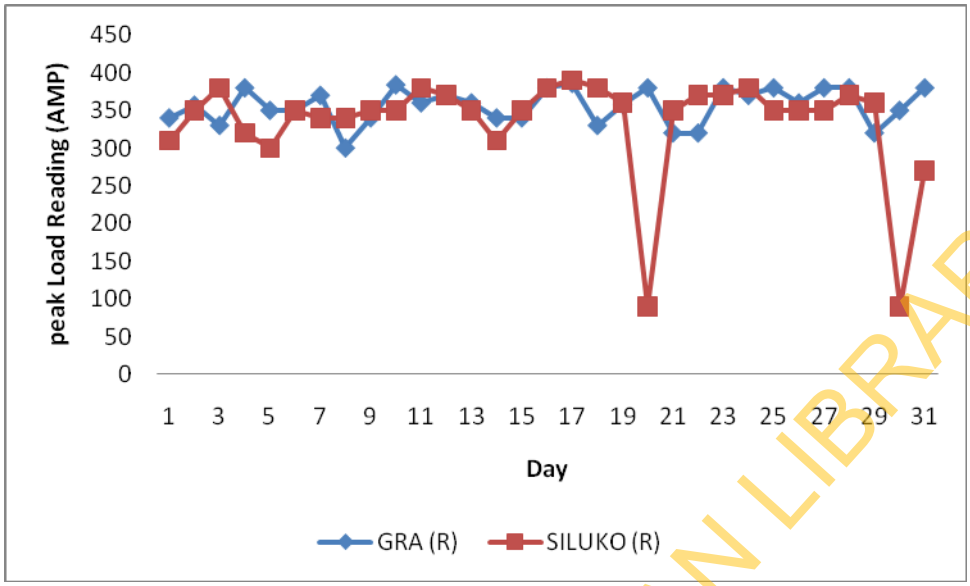

Fig. 2: Mean Daily Peak Load Readings for GRA and Siluko Injection Substations (Yellow Phase).

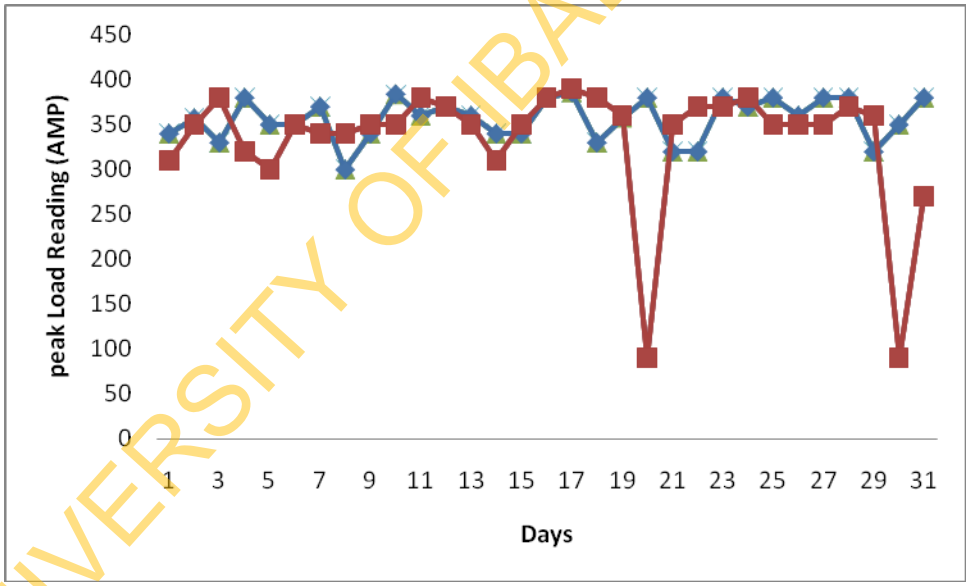

Fig. 3: Mean Daily Peak Load Readings for GRA and Siluko Injection Substations (Blue Phase).

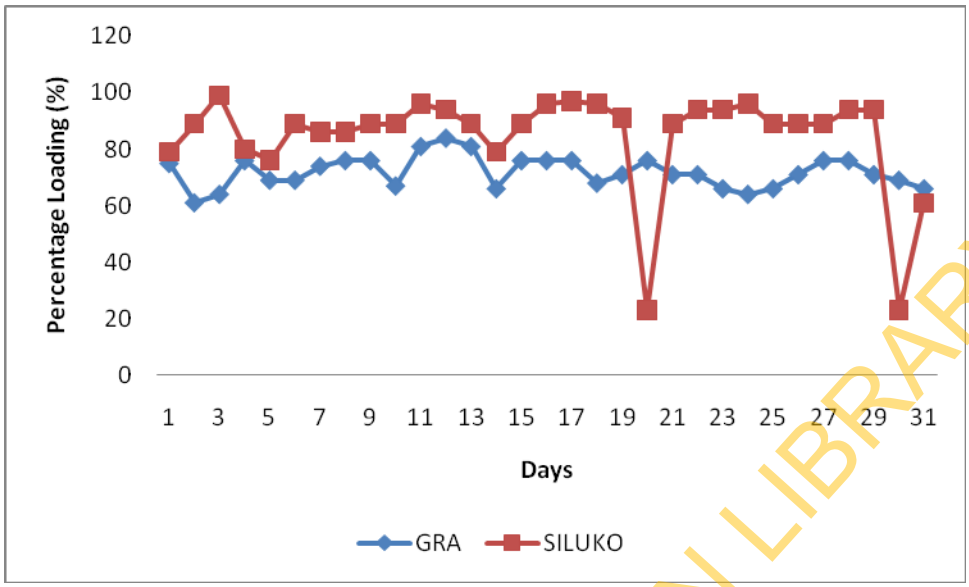

Fig. 4: Mean Percentage Loading

DISCUSSION

Electric power outages were found to be very frequent in Benin City area of Nigeria and were due to various factors among which are the following: Planned outages which were normally arranged to permit planned maintenance, repair or modification work on in - service equipment and also to enable new equipment to be installed and put into service. Automatic or forced outages are outages caused by different types of inadvertent or unintentional faults in the power supply system. Such faults were found to occur fairly frequently due to storm, lightening, strike action, contractors excavating PHCN underground cables, vehicles hitting PHCN poles and overhead circuits, earth – faults, and human errors. Emergency outages which are such outages that are neither planned nor automatic. Emergency actions leading to outages, such as load shedding, were sometimes embarked upon in order to save the equipment or system from imminent danger or failure. At a high winding temperature of about 78^0C, the transformer trips off automatically to prevent transformer's explosion. Accordingly, whenever the need arose, load shedding was embarked upon to reduce the load, and hence, the temperature, so as to save the life of the transformer.

CONCLUSION

The perennial problem of electric power supply in Nigeria has adversely affected every sector of the nation economy. The study has identified and discussed some of the factors that are responsible for inadequate and irregular supply of electric power in the Benin City area of Nigeria. It was found that most of the major factors affecting the availability of power supply could be grouped into two major classes. The first consists of those arising from policy actions, which are deliberate in nature and they are usually taken to safeguard the equipment. They include such actions that are taken during emergency outages, planned or per-arranged outages as well as load-shedding. On the other hand, the other class includes those arising from forces external to the system, and they include over- current, earth fault, high peak load, as well as forced or automatic outages. However, some of the latter may lead to the former.

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