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Analysis and Evaluation of Eket 132/33kv Transmission Station Loading Profiles for Consumer Power Utilization

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Abstract- Efficient electric power transmission is a major concern in Nigeria. Power supply from Eket 132/33kV transmission station has not been regular. This became a strong reason for analysis and evaluation of Eket 132/22kV transmission station loading profiles for consumer power utilization. The problem associated with this work is that there is always a over-loading of the network which has advert effect on the system under review. The load profiles were carried out due to several faults which were specifically in the network. The aim of this research work is to evaluate and analyse Eket 132/33kV transmission station, loading profiles for consumer power utilization. A performance evaluation of the Eket 33kV feeders using Newton Raphson load flow method was used to ascertain the status of the networks for improved performance. Load profiles for Onna 33kV feeder, Eket I 33kV feeder, Eket II 33kV feeder, Mbo 33kV feeder, Abak 33kV feeder and Etinan 33kV feeder are 95.9, 55.4, 146.8, 44.5 and 44.5. Onna load became insignificant and was recorded for 24 hours of the day. Simulation were carried out and results were obtained and presented on tables and in bar-chart which lead to proper discussion of the network. Finally, faults so far identified if well addressed will increase the load profiles of the station.

I. INTRODUCTION

A.C. is the type of electrical power system used today. Alternating current is used to produce, transmit, and distribute electric power. It is distributed across a vast network of transmission and distribution to reach the users. It may be desired and required to alter a certain electric supply characteristic at numerous points along the power system's line (e.g., voltage, A.C. to D.C. conversion, etc.). A suitable piece of equipment called a sub-station carries out this function. For instance, the power plant may step up the generating voltage (11KV or 6.6KV) to a high voltage (such as 132KV or 330KV) for the purpose of transmitting electric power. The sub-station is the collection of equipment (such as a transformer, etc.) utilized for this purpose. Similarly, near the consumer's localities, the voltage may have to be stepped down to utilization level. This project again accomplished by a suitable apparatus called 'substation. The Eket 132/33kV transmission substation is located at Eket. The sub-station gets its 132kV supply from the national grids through Uyo and Ibom generating stations with total capacity of 180MW. The Ibom generating station serves as primary station that feed the sub-station through which energy is transported to the grid, and it is the primary supply to Eket sub-station. The other incoming supply through Uyo generating station serves as secondary feed to the sub-station in the event that Ibom generating station is out of services due to fault or as may be instructed by National Control Centre (NCC) Osogbo. The Ibom generating station, Eket 132Kv HV from the grid-Uyo and 33V LV distribution section of the sub-station are as depicted in Figure 1, Figure 2 and Figure 3 respectively. While Figure 4 and Figure 5 depicted Common 132kV bus and Common 33KV buss / Isolator, also Figure 6 60/45 MVA 132/33 kV Transformers respectively. The 3-phase 132kV HV line comes into the substation through lighting arrestor. Lighting arrestor in a transmission setup is use to protect the grid against surges due to lighting. After the arrestors are earth switches then isolators follow by main breaker, this comes the need to measure the voltage and current in the transmission lines. For that a Capacitor Voltage Transformer (CVT) and Current Transformer (CT) are used. Just like an ammeter and a voltmeter, a CT linked serially to transmitting lines whereas a CVT linked parallel to transmission lines. Since they are transformer they must have a transformation ratio. In Eket 132kV sub-station the transformation ratio of these instrument transformers is 400:1 step down.

II. STATEMENT OF THE PROBLEM

The supply source for Eket Township and its surroundings will be carefully examined, In this project, the feeder load forecast will be made using some approaches to obtained statistical data. The problem associated with this work is that there is always a over-loading of the network which has advert effect on the system under review. This approach will be simple (extrapolation approach) is quite straightforward and easy in practice because it provides a better estimation of the regression line and, as a result, eliminates the human error inherent in other methods for load forecasting. Other methods are known in the literature (Nwachukwu, 2006).

- OBJECTIVES

i. Assessing the present state of the transmission lines using information gathered from a field survey, namely from the Transmission Company of Nigeria (TCN) Eket Substation.
ii. Making use of the simulation's base-case findings to enhance the overall actual and reactive power flow and guarantee that there is a decrease in power loss on the 132kV Sub-transmission network.
iii. To improve the networks using active (generator) and passive (capacitor banks) components.
iv. Model the existing network for analysis and evaluation

III. LITERATURE REVIEW

Low-voltage power generation is fairly efficient, but high-voltage power generation is more affordable. Numerous switching and transformation stations must be built between the generator and the client ends in order to maintain high and low voltage levels. They are typically referred to as electrical substations (Ogbuefi & Madueme, 2015).

High voltage system electricity is a substation that can be utilized in controlling machinery, generator, etc. The major function of the substations is the conversion of AC to DC. Some substation types come in compact sizes and include switches and a transformer right within. Other types of substations are enormous and have various, circuit breakers, and switches (Ogbuefi & Madueme, 2015).

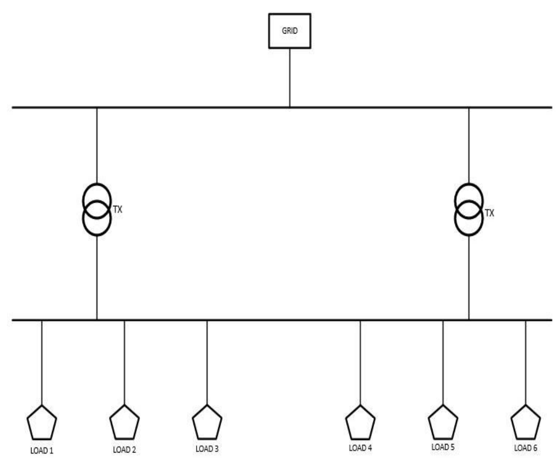
Voltage instability in distribution systems could be seen as an abnormal situation in the power system caused by disturbance, an increase in load demand, or a change in system condition or coordination that results in a gradual drop in voltage. Gayathrl (2022)

IV. MATERIALS AND METHOD

This chapter presents in details the materials and method used for the analysis of the system under reviw. Block diagram representing EKET 132KV single line diagram are shown in figure 3.1. and the power system software employed for the network simulation using (Electrical transient analysis program) (ETAP).

The network block diagram comprises of the grid, two step down transformers and six feeders.

Block diagram physical representation of Eket 132/33KV network 132/33KV



Network Block Diagram
Block diagram of Eket 132/33 network

The network has been assembled in ETAP showing all the elements of the network from the grid to the feeders as well as the step-down transformers

Table 3.1 shows the data of the network gotten from Eket 132/33KV substation data sheet. The data include the load performance of all six 33KV feeders listed as follows: ONNA, MBO, ABAK/ ETINAN, EKET1 AND EKET 2

Table 3.1: 33KV Feeder Load Profile

S/N	TIME	ONNA	MBO	ABAK/ETINAN	EKET2	EKET
1	1:00	ON	120	40	80	ON
2	2:00	ON	120	E/F	80	ON
3	3:00	ON	120	E/F	80	ON
4	4:00	ON	120	E/F	80	60
5	5:00	ON	100	E/F	10	60
6	6:00	ON	110	E/F	10	70
7	7:00	ON	110	60	60	130
8	8:00	ON	100	60	60	140
9	9:00	ON	170	40	90	140
10	10:00	ON	170	40	90	140
11	11:00	ON	170	40	80	80
12	12:00	ON	170	40	80	80
13	13:00	ON	130	40	90	ON
14	14:00	ON	160	40	90	ON
15	15:00	ON	E/F	40	40	ON
16	16:00	ON	E/F	40	40	ON
17	17:00	ON	E/F	40	10	ON
18	18:00	ON	80	40	10	ON
19	19:00	ON	100	50	10	ON

- Method

The method used in this research work is" Newton Raphson" here, it considered the application embedded in Newton Raphson Load Flow Study.

Table 3.2 shows the load profile of Onna 33kV feeder.

Table 3.2: Onna 33KV Feeder Load Profile

Onna 33KV Feeder

S/N	TIME	ONNA 33KV FEEDER
1	1:00	ON
2	2:00	ON
3	3:00	ON
4	4:00	ON
5	5:00	ON
6	6:00	ON
7	7:00	ON
8	8:00	ON
9	9:00	ON
10	10:00	ON
11	11:00	ON
12	12:00	ON

13	13:00	ON
14	14:00	ON
15	15:00	ON
16	16:00	ON
17	17:00	ON
18	18:00	ON
19	19:00	ON
20	20:00	ON

The load profile of the ONNA feeder from the substation shows that the feeder performance as at when it was submitted was on but not delivering power, there for there was no power consumed on the load end of the feeder for that particular duration of which the data was acquired for this work.

3.3 Load Profile for MBO 33KV Feeder

Table 3.3 represents the load profile of Mbo 33kV feeder

Table 3.3: Mbo 33KV Feeder Load Profile

S/N	TIME	MBO 33KV Feeder
1	1:00	120
2	2:00	120
3	3:00	120
4	4:00	120
5	5:00	100
6	6:00	110
7	7:00	110
8	8:00	100
9	9:00	170
10	10:00	170
11	11:00	170
12	12:00	170
13	13:00	130
14	14:00	160
15	15:00	E/F
16	16:00	E/F
17	17:00	E/F
18	18:00	80
19	19:00	100
20	20:00	230

The Load profile for MBO 33KV feeder is shown in the above table with energy consumed in Ampere ranging from 80Amps to 200Amps. The average usage in ampere on the MBO feeder as at the duration of the collected data is 145.7Amps. This average value will be used for the simulation in ETAP.

Applying Kirchhoff's Current Law to bus I;

Thus;

$$I_i = V_i \sum_{k=0}^{n} Y_{ik} - \sum_{k=0}^{n} Y_{ik} V_{k,k\neq i} \quad (3.3)$$

The real and reactive power at bus I is given as;

$$S_i = P_i + jQ_i = V_i I_i^* \quad (3.4)$$

We can also say that;

$$I_i = \frac{s_i^*}{V_i^*} = \frac{P_i - jQ_i}{V_i^*} \quad (3.5)$$

Using equation 3.4 to substitute into equation 3.2 gives;

$$\frac{P_i - jQ_i}{V_i^*} = V_i \sum_{k=0}^{n} Y_{ik} - \sum_{k=0}^{n} Y_{ik} V_{k,k\neq i} \quad (3.6)$$

or

$$P_i - jQ_i = V_i^* \sum_{k=0}^{n} V_i Y_{ik} - V_i^* \sum_{k=1}^{n} Y_{ik} V_{k,k\neq i} \quad (3.7)$$

V. RESULTS

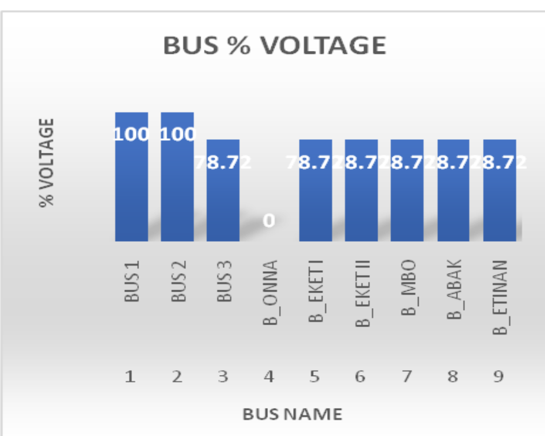
This chapter presents the results and it discussion on how it was achieved. The image in Figure 4.1 shows the network in ETAP load flow showing all the bus performance as well as power flow along the network. The bus performance is shown in voltage percentage as regards to their respective Kilo volts.

Table 4.1 shows the respective buses and their % voltage performance at simulation with the range of performance in between 98.7% and 100%.

Table 4.1: Network Bus Performance.

S/N	Bus Name	% Voltage
1	Bus 1	100
2	Bus 2	100
3	Bus 3	98.72
4	B_Onna	-
5	B_Eket I	98.72
6	B_Eket II	98.72
7	B_Mbo	98.72
8	B_Abak	98.72
9	B_Etinan	98.72

Network Graphical Percentage Bus Performance



Graphical % Bus Performance

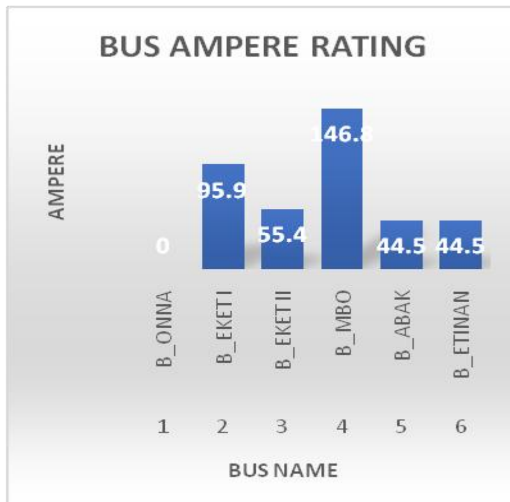
The network in power flow mode but with bus performance not in voltage percentage but in terms of power factor and currents.

Network in Load Flow Mode

Table 4.2: Bus Ampere Performance

S/N	Bus Name	Ampere
1	B_Onna	-
2	B_Eket I	95.9
3	B_Eket II	55.4
4	B_Mbo	146.8
5	B_Abak	44.5
6	B_Etinan	44.5

Network Graphical Performance in Terms of Current



Bus Ampere Performance

CONCLUSION

It therefore concluded from the research carried out that the electrical distribution system in Akwa Ibom state has significant flaws, including broken insulators, severed strays, bent or broken poles, misplaced and damaged straps, broken cross arms, leaky transformers, overloaded transformers, bushy distribution substations, and broken insulators (Eket as a case study). The total number of defects recorded during the research for Eket is 18 in number.

REFERENCES

[1] Amadi, H.N., Okafor, E. N. C. &Izuegbunam, F. I. (2016). Assessment of Impact of Outages in Selected Electricity Intensive Industries in Nigeria.*International Journal of Research in Engineering & Technology, 4*(10), 9-24.

[2] Awosope, A. A. (2014). Nigerian electricity industry: Issues, challenges and solutions. *Public Lecture Series, 3*(2), 6-22.

[3] Azodo, A.P. (2014). Electric Power Supply, Main Source and Backing: A Survey of Residential Utilization Features. *International Journal of Research Studies in Management, 3*(2), 87-102.

[4] Begovic, M. B. M. &Novosel, D. (2002). A novel method for voltage instability protection, A paper presented at the 35th IEEE Annual International Conference on System Science, 802-811, Hawaii.

[5] Gupta. J.B. (2012). Transmission and distribution of electrical power (New Delhi: S. K. Kataria&) Son,

[6] Hamouda, A. &Zehar, K. (2007). Improvement of the power transmission of distribution feeders by fixed capacitor ban. *Acta PolytechnicaHungarica,*