Outage Analysis on Distribution Feeder in North East Nigeria

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***Abstract*—The paper is aim at analyzing the outages on the feeders of the distribution system, in Maiduguri, Borno state, Nigeria. The 33kV feeders are the Damasak, Maiduguri and Damboa feeders. The analyses are based on monthly outage data collected for a period of about two years (2008 to 2009).The type, number and duration of the outages was identified. From the data the plots of the outage distribution were obtained. The result indicates the outages are mainly due to ageing of equipment, lighting, vandalisation and poor maintenance. Possible reasons for the causes of the outages were presented and appropriate recommendations were proposed.**

Keywords*— *High voltage; Distribution System; Feeders; Current interruption

I. INTRODUCTION

The Electrical utility is probably the largest and the most complex industry in the world. The electrical engineer, who researches in the industry do have challenges in designing future power system to deliver increase amount of electrical energy in a safe, clean and economical manner [1]. The transmission network in Nigeria is characterized by several outages leading to disruption in the lives of the citizens.

According to [2], the level of disruption is a function of dependency of people on electricity which can be very high for a developed country and low for developing countries. In Nigeria the available power generated is not enough to meet the demands of the users leading to constant load shedding and blackouts.

All the three feeders i.e. Maiduguri, Damasak and Damboa, are associated with high winds, especially when combined with precipitation from seasonal storms, can cause damage to electricity utility systems, resulting in service interruptions to large numbers of electricity customers. While most such power outages are caused by damage from trees and tree limbs falling on local electricity distribution lines and poles, major power outages in these area are tend to be caused by damage to electricity transmission lines which carry bulk power long distances, human error and improper operation of equipments . Depending on the severity of the storm and resulting impairment, power outages can last a few hours or extend to periods of several days, and have real economic effects [3, 4, 5].

A number of works similar to the present one have been presented in the past. The outages on the Zaria feeders in Kaduna state, an attempts to identify the causes and effects of the outages on 33kV feeders was made and possible solution were proposed.

In this paper, however, the outages on the distribution feeders of Damasak, Damboa and Maiduguri distribution network are closely considered. Their performance were evaluated in terms of the outages on them between January 2008 to December 2009,being a period considered to be the most recent by power holding company of Nigeria (PHCN) at the time of the research.

A. Electrical Outages on Distribution Feeders

Power outages (also power cut, Blackout or power failure) is a short or long term loss of electric power to an area.

There are many causes of power failure in an electricity network. Example of these cause include faults at power stations, damage to electric transmission or distribution lines, substation faults, short circuit, open circuit or the over loading of the electricity mains.

Power outages are particularly critical at sites where the environment and public safety are at risk. Institutions such as hospitals, sewage treatment plants, mines etc. will usually have backup power sources, such as standby generators which will automatically start-up when electrical power is lost. Other critical systems, such as telecommunication, industries are also required to have emergency power [6]. The National control center (NCC) a unit of the power Holding Company of Nigeria (PHCN) stimulated in its operational procedure that power stations and transmission stations are required to forward their planned outages schedule for the following year to the NCC, lasted by end of the month of November. This enables NCC to plan a master program of planned outages properly coordinated to ensure maintenance of Grid integrity after a thorough study and analysis of the various outages.

B. Causes And Effect Of Power Outages On The Network

Most of the transmission lines are very long and fragile leading to frequent conductor cuts. This gives rise to high voltages drop and power losses in the network. The voltage can be as low as 21kV for 33kV line and 92kV for 132kV lines [7].

Single line contingency and small conductor sizing are major features in most lines in the network. Thus, high volt voltages drops are associated with such lines and they are also subjected to constant tripping and have to run at very high voltage up to 150kV for 132kV lines to be able to operate at acceptable limits [7].

High voltages are experienced in some very long lines where the rectors are out of circuit due to low resistance winding faults and damaged cables.

C. Outages Classification

A partial outage describes a component state where the capacity of the component to perform its function is reduced but not completely eliminated. A total outage is an outage where the component is completely incapable of performing its function.

A forced outage is an outage that result from emergency conditions directly associated with a component, requiring that component be taken out of service immediately, either automatically or as soon as switching operations can be performed or an outages caused by improper operation of equipment or human error. Forced outages can be associated with ageing equipment/defects, lightening, wind, bird/animals, vandalisation accidents and poor job execution by contractors. However forced outages can be minimized if the system is properly designed and maintained but not completely eliminated [8].

Planned outage: Planned outages are outages due to planned or scheduled maintenance when a component is deliberately taken out of service at a selected time, usually for purposes of construction, preventive maintenance or repairs. This could be either on the distribution networks or substation equipment.

Emergency outages: arises from loss of power supply from the generating station either due to inadequate generation or drop in the load coordination frequencies. The normal frequency is 50Hz.

II. METHODOLGGY

Data on forced, planned and emergency outages for 3 Nos, 33 kV line feeders of Damasak, Maiduguri and Damboa were obtained for three years from 2008 to 2009.Graphical representations of these outages on monthly basis were used for the outage analysis on 3Nos of 33 kV line feeders that used SF_6 as their interruption medium. The following method was adopted for this paper.

1) Data collection for the three feeders which are shown in tables I-VI.

2) Graphical representation of power outages in the 33 kV networks.

3) Analysis of these graphical representations to highlight the problems on these 33 kV feeders and recommend action on how to minimize these outages.

The Damasak and Maiduguri 33 kV feeders have their sources here in the Maiduguri 132/33 kV Transmission/Distribution Station, while the Damboa 33 kV feeder emanate from the 132/33 kV Damboa Transmission Station. Maiduguri feeder supplies Shehuri, Kumshe, Lawan Bukar, Mafoni, Bolori and Hausari Wards,while the Damboa feeder supplies Damboa town and it environment and the Damasak feeder supplies Damasak and some parts of Niger Republic.

TABLE I. PLANNED OUTAGES FOR THE YEAR 2008

Feeder	**Months**											
	Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
Damask	0	1	1	1	1	0	4	2	2	2	0	0
Maiduguri	0	0	0	0	0	0	0	0	0	0	0	0
Damboa	0	0	0	0	0	0	0	0	3	3	0	1

TABLE II. FORCED OUTAGES FOR THE YEAR 2008

Feeder	**Months**											
	Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
Damask	11	03	14	08	07	15	15	27	24	03	09	08
maiduguri	00	02	02	01	01	00	00	22	00	00	01	00
Damboa	04	04	00	02	02	04	07	04	02	04	05	00

TABLE III. EMERGENCY OUTAGES FOR THE YEAR 2008

Feeder	**Months**											
	Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
Damask	07	07	00	00	01	01	04	01	00	00	00	01
Maiduguri	17	04	13	14	08	06	24	00	10	15	31	28
Damboa	35	24	11	30	17	13	14	21	00	00	24	18

TABLE IV. PLANNED OUTAGES FOR THE YEAR 2009

Feeder	**Months**											
	Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
Damask	0	2	3	0	1	2	2	5	3	3	4	
Maiduguri	0	0	1	0	0	0	0	0	0	0	0	
Damboa	0	0	0	0	0	0	0	0	0	2	0	

TABLE V. FORCED OUTAGES FOR THE YEAR 2009

Feeder	**Months**											
	Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
Damask	21	18	21	08	07	11	16	47	28	28	12	
Maiduguri	0	5	0	0	0	2	0	1	1	1	1	
Damboa	5	0	0	3	1	1	0	3	3	3	4	

TABLE VI. EMERGENCY OUTAGES FOR THE YEAR 2009

Feeder	Months											
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Damask	0	1	0	0	0	2	1	0	0	0	0	
Maiduguri	17	15	35	28	21	25	23	24	36	36	36	
Damboa	16	26	39	33	26	25	40	28	26	26	32	

III. RESULTS AND ANALYSIS

The Damboa 33kV line feeder recorded the highest number of planned outages in 2008 as shown in Fig.1

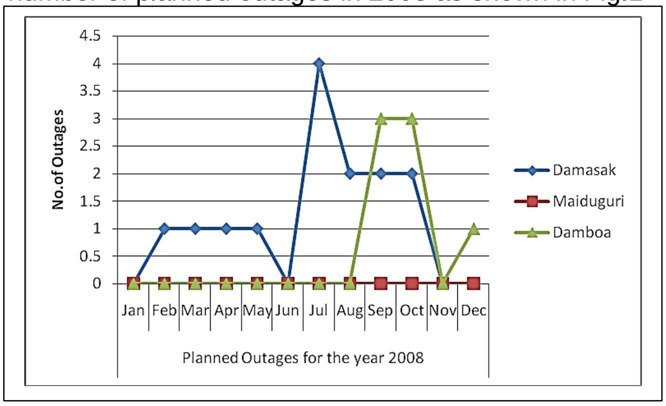

Fig. 1. Planned outage in 2008

The 33kVDamboa feeder with a route length of over 470km was characterized by several maintenance activities during the rainy month of September, October and November of that year. Hence the high the highest outage may be attributed to this.

Fig. 2 shows the forced outage recorded in 2008 on Damasak feeder. The Damasak 33kV line feeder recorded the highest number of forced outages in 2008, this could be due the nature of terrain covered by the feeder and hence the devastating effect of wind storm during the rainy period of August, September up to October of that year.

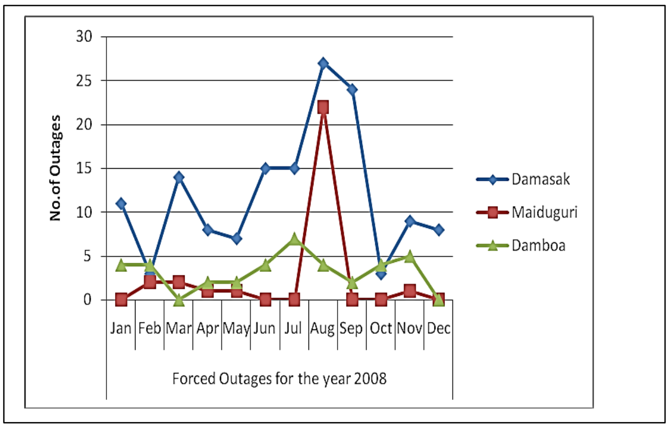

Fig. 2. Forced outage in 2008

The 33kV Maiduguri feeder recorded the highest number of emergency outages in 2008 as shown in Fig.3

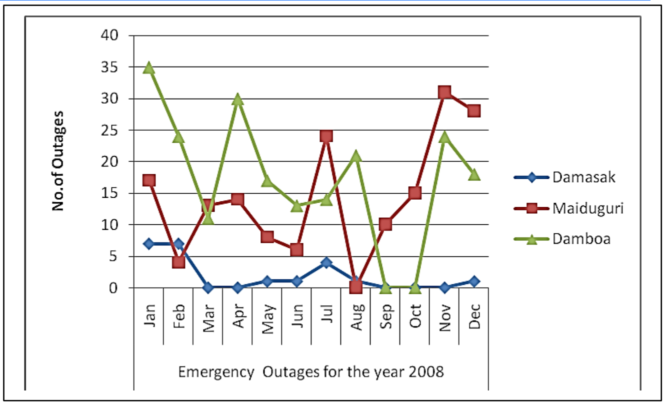

Fig. 3. Emergency outage in 2008

The Maiduguri feeder recorded the highest number of emergency outage in 2008. The most probable cause of this is the high load demand

From the result above it can be seen that The Damasak 33kV feeder recorded its highest number of planned outage in August, while Damboa recorded highest in October, for Maiduguri feeder there was no planned outages at all throughout the 2008. These could be attributed to the frequency of tripping on the SF_6 breakers during the rainy months of July and August and hence the need to carryout routine maintenance on SF_6 circuit breakers for the two affected feeders.

Damasak and Maiduguri 33 kV feeder recorded their highest number of forced outages in the month of August, while Damboa recorded its highest number of force outage in July. These could be attributed to the fact that July and August are the rainiest months which are susceptible to strong windstorms that cause a lot of disruption to the network.

In 2009, the 33kVDamasak feeder recorded the highest number of planned outages as shown in Fig.4

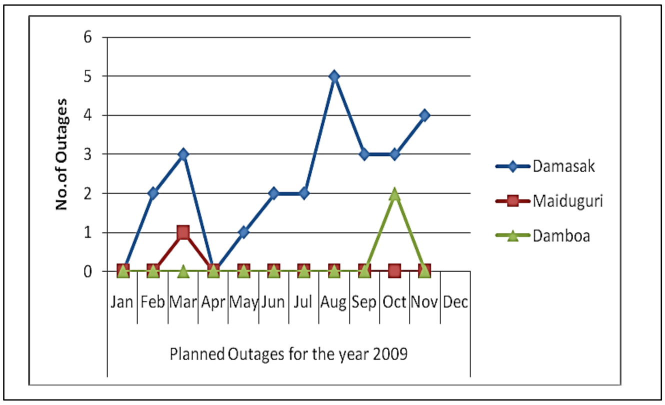

Fig. 4. Planned outage in 2009

This could be as a result of incidence of network disruptions due mainly to vehicular accidents along the Damasak-Difa road.

As can be seen from Fig.5, the 33kVDamasak feeder also recorded the highest number of forced outages in 2009 during the rainy period of August and September due to heavy wind storms that characterized the rainy period.

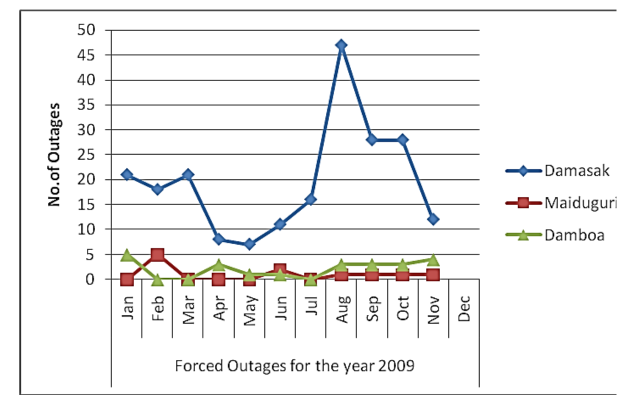

Fig. 5. Forced outage in 2009

Damasak recoded its highest number of forced outages in the months of April, May and June because these are period preceding the rainy season and are characterized by heavy windstorm capable of causing enormous damages to the network, and hence frequent tripping of the feeder. Maiduguri recorded its highest in February while Damboa recorded its own in September.

Fig.6 shows the emergency outage of 2009, Damasak had the highest number of planned outage in November while Maiduguri and Damboa virtually had no planed outage except in March and October.

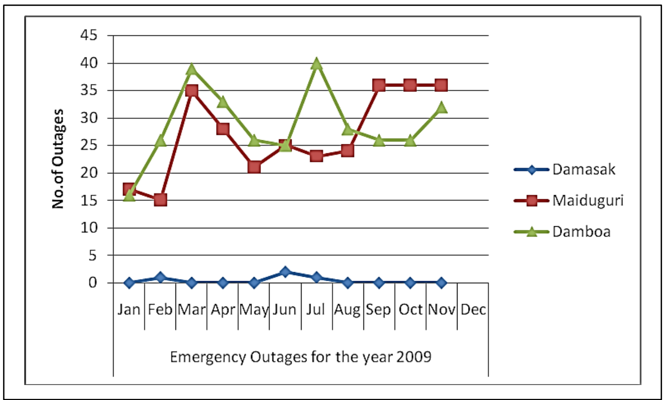

Fig. 6. Emergency outage in 2008

IV. CONCLUSION

The various causes and effects of power outages in 33kv in the network have been examined in this study. Outages in the network are due to ageing of equipment and defects, lighting. Vandalisation, poor maintenance etc. The fault analysis showed that the system needs to be properly protected to ensure safety and security of network. From the result and analysis of the various natures of outages on the three (3) number of 33kv line feeder namely Damasak, Damboa and the Maiduguri feeders, the following recommendation are hereby made;

1) Upgrading the existing 132kV/33kV substations will be constructed to create additional ones.
2) Upgrading the existing 2x45MVA, 132/33kV transformer to 2x90MVA, 330/132kV transformer to cope with the increase load demand.
3) Replacement of all the existing 33ft. concrete poles on the 33kv feeders with 33kV mini towers to forestall the effect of windstorm, with a view to minimizing the rate of forced outage on the 33kv feeders.
4) Replacement of all the existing 33kV cross arms with channel iron to reduce the rate at which 33kV feeder trip on earth fault which consequently reduce the number of forced outage on the 33kV feeders.
5) Replacement of all cracked pin and disc insulators on the 33kV overhead lines with a view to minimizing the incidences of forced outages.

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