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Electric Power Transmission Line Faults in Nigeria: A Case Study of Benin-Irrua 132 KV Transmission Line

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Abstract: This study highlight the faults analysis on Benin-Irrua 132 KV transmission line, associated with Benin District of Power Holding Company of Nigeria (PHCN). Data used for analysis covers a period of a year (July 2006 to June 2007). The analysis revealed the causes of different types of faults and problem associated with the 132 KV feeder between Benin-Irrua transmission line. A total of 71 faults occurred in a year, fault A has the highest frequency of occurrence. The month of January has the highest faults. The total duration of power outage in a year was 151 h. 06 min and also the month of October has the highest duration of power outage followed by July. The causes of faults on an Electric Power Transmission Line and the possible solution to reduce these faults will be of relevance to Power Holding Company of Nigeria (PHCN) and Power System Engineers.

Key words: Transmission line faults, substation load, transmitting station, load loss, distribution network, substation

INTRODUCTION

A stable and reliable electric power supply system is an inevitable pre-requisite for the technological and economic growth of any nation. The need for a stable and reliable electric power supply cannot be overemphasis for a developing town like Benin -Irrua region.

In the late 70's when the national peak generation exceeded demand, electric power supply was very reliable but the reverse is the case now resulting to an epileptic power supply. As the load and population grow, generation, transmission and distribution must be increased to cope with the growth. Expansion of electric power supply system must be planned years in advance. The validity of such planning depends to a great extent on the quality of the forecast and future substation load upon which plan is based (Brown, 2002).

Most of the power outages experienced in Benin-Irrua transmission line are partly as a result of faulty equipment within the transmission system. Poor maintenance culture increases the rate of occurrence of the faults.

MATERIALS AND METHODS

The source of data for this analysis was from daily fault report and logbooks available at the Benin transmission office on BENIN-IRRUA 132 KV transmission line and from other literature. Data used for analysis covers a period of a year (July-2006 to June 2007) (PHCN, 2006-2007).

Benin-irrua 132 KV transmission line: The Benin district at Sapele Road is connected from the national grid at a voltage of 330 KV, this voltage is stepped down by 90 MVA transformer to a voltage of 132 KV and the 132 KV is fed into the 132 KV bus bar and further stepped down to a voltage level of 33 KV by T_2 1×30 MVA transformer. Base on effort to increase total mega-watt generated from various generating station, there have being constant power from the generation station, but fails to get to the consumers. The Irrua sub-station, is connected from Benin district at Sapele Road, feeding Ubija, Agenebode and Uzebba.

The reliability and quality of power distribution system can be enhanced by the presence of sophisticated equipments. Some of the principal units associated with power transmission are: transformers, reactors, switch gears, circuit breakers, feeder pillars, ring main units, fuses isolators etc.

Schmatic diagram of Irrua sub-transmitting station is shown in Fig. 1.

The Irrua sub-transmitting station has four feeder, Ubiaja, Agenebode, Uzebba feeder and Spare feeder for redundancy (PHCN, 2006-2007).

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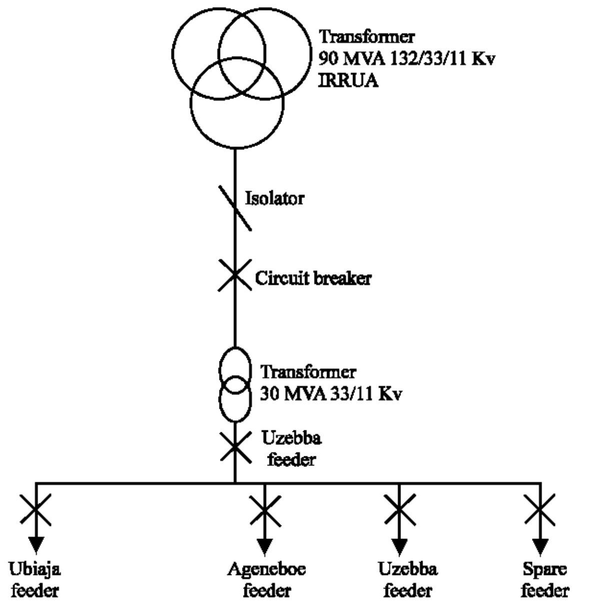

Fig. 1: Schematic diagram of irrua sub-transmitting station

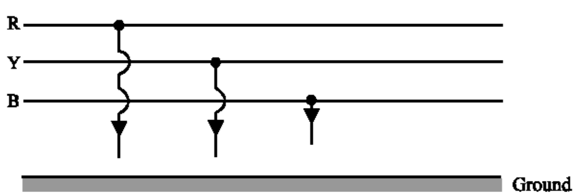

Fig. 2: A balance 3-ϕ fault

Problems with benin-irrua 132 KV transmission line: The expected operating mode of a power system is balanced three phases AC. However a number of undesirable but unavoidable incidents can temporarily alters this condition (Theraja, 2002). The problem go as far to delay rectification of faults and even abandonment of faulty equipment for so long. Most of the problem facing 132 KV Benin-Irrua transmition power supply as follows:

- Planned outage (lack of adequate planning).
- Weather problems.
- Shortage of manpower.
- Vandalization of electrical equipment.
- Poor financing.
- Negligence of power holding company staff and institutional staff.
- Problem of load shedding.

Types of faults in power systems: Faults in electricity distribution can be defined as disturbance or anything that causes power supply to be alter or disrupted abruptly (Francis, 1971).

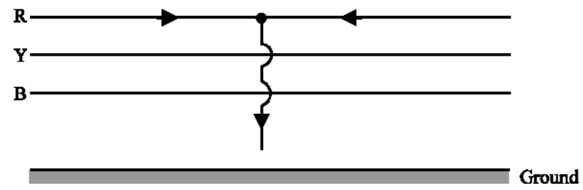

Fig. 3: Single line to ground fault

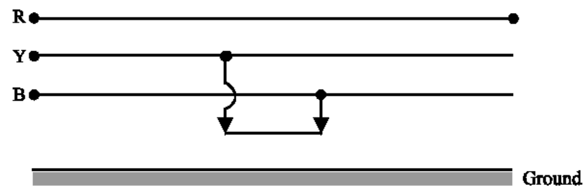

Fig. 4: Line to line fault

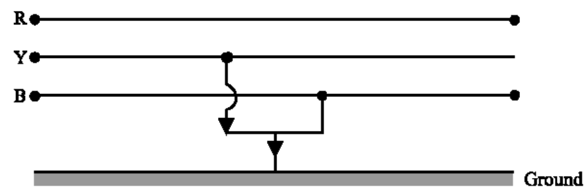

Fig. 5: Double line to ground

Three phase balance fault: These types of fault account for about 5% of all faults, which occur in electric power transmission. This fault occurs when the 3 phase, red-phase, yellow-phase, blue-phase, they have a common fault also link to ground or earth (Fig. 2).

Single line to ground fault: This type of fault account for about 70-80% of faults that occur, which result interrupt power supply in the country. This fault occurs when any one of the phases has contact with the ground or earth (Fig. 3).

Line to line fault: This occur when two lines such one red phase line touch the yellow phase line or when the yellow phase touch the blue phase line touch the red phase (line) (Fig. 4).

Double line to ground fault: This occurs when different line or phases are touching each other and having a contact with the ground or short-circuit linking the ground (Hughes, 1987) (Fig. 5).

Double line ground fault: This occurs when two different lines or phases have contact with the ground, without the 2 lines touching each other (Fig. 6).

Open line or open circuit: This occurs when there is discontinuity in an electric system or line. This also refers to disconnection or open-circuit (Fig. 7).

Data collection and analysis: This data was collected in (PHCN) NEPA office at Benin-Irrua transmission office at Irrua, during the period 2006 July to June 2007 (PHCN,

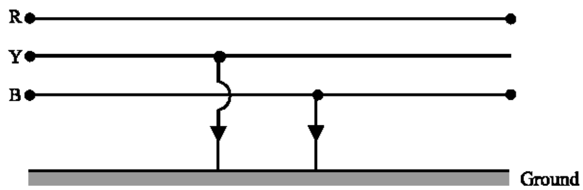

Fig. 6: Double line ground fault

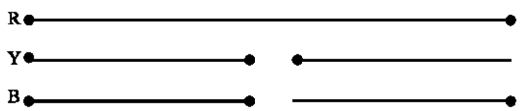

Fig. 7: Open line fault

Table 1: Fault data

Months	Faults/Reasons For interruption	Time duration	Load loss
July	A	36 min	46 MW
	B	2.17 min	Negligible
	A	59 min	10 MW
	B	9.10 min	45 MW
	A	6.8 min	15 MW
	A	4.19 min	14 MW
August	A	15 min	19 MW
	A	45 min	10 MW
	B	12 min	14 MW
	A	12 min	15 MW
	C	3.33 min	10 MW
September	A	17 min	Negligible
	B	19 min	19 MW
	A	18 min	11.0 MW
	A	51 min	10.0 MW
	D	4.54 min	34. MW
	B	2.13 min	40. MW
	A	1.44 min	49. MW
	C	1.5 min	65. MW
October	C	1.9 min	45 MW
	C	1.37 min	30 MW
	D	9.44 min	
	C	8.13 min	44 MW
	A	30 min	88 MW
	D	8.36 min	16 MW
	D	6.16 min	40 MW
	A	21 min	52 MW
November	B	50 min	46 MW
	A	2.25 min	55 MW
	A	4.30 min	
	A	17 min	45 MW
	A	37 min	10 MW
	B	17 min	41 MW
	B	42 min	42 MW
December	B	31 min	55 MW
	C	38 min	30 MW
	B	34 min	40 MW
January	A	36 min	44 MW
	A	42 min	9. MW
	B	59 min	35 MW
	B	43 min	50 MW
	B	56 min	40 MW
	B	23 min	22 MW
	A	2.30 min	40 MW
	A	7.32 min	-
	E	3.45 min	Negligible
February	B	39 min	50 MW
	A	40 min	20,W
	A	19 min	40 MW
	A	15 min	6 MW
March	E	9.10 min	42 MW
	A	1.23 min	20 MW
	A	33 min	5 MW
	C	1.55 min	2.5 MW
	A	11 min	14 MW
	B	10 min	40 MW
	A	47 min	18 MW
April	A	10.54 min	9 MW
	A	1.33 min	70.9 MW
	D	8.16 min	40 MW
May	A	1.28 min	40 MW
	A	2.18 min	45 MW
	C	11 min	50 MW
	A	22 min	8 MW
June	A	10 min	24 MW
	B	1.33 min	24 MW
	B	46 min	7 MW
	B	18 min	40 MW
	B	28 min	8 MW
	A	17 min	Negligible
	B	34 min	40 MW

Faults: Reasons for Interruption, A: Was out to enable (PHCN staff) work on the transmission line, to replenish the breaker with gas and replacement of faulty isolators and replacement of some faulty equipments, B: Tripped on Open Circuit (OC) and Short-Circuit (SC), C: Open on load shedding, D: Tripped on system collapse, E: Tripped on phase to ground

Table 2: Monthly types of faults documentation

Types faults	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total nos. of each particular of fault in a year
A	4	3	4	2	3	2	4	3	4	1	4	-	34
B	4	1	1	-	-	5	2	1	2	-	3	2	21
C	-	-	1	-	1	-	-	1	1	4	-	1	9
D	-	-	-	1	-	-	-	-	1	3	-	-	5
E	1	-	1	-	-	-	-	-	-	-	-	-	2
Total no of fault in each months	9	4	7	3	4	7	6	5	8	8	3	3	71

Table 3: Monthly time outage due to different types of faults

Types of faults	Min Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total time in each particular of fault in a year
A	12.02	1.12	3.10	12.2	4.08	27	11.20	1.14	2.54	30	7.49	-	57.13
B	11.27	12	2.32	-	-	3.39	3.01	37	10	-	1.49	1.04	24.31
C		3.33	1.05	-	11	-	-	-	1.55	11.20	-	38	18.42
D	-	-	4.54	8.16	-	-	-	-	-	24.36	-	-	37.46
E	-	-	-	-	-	-	3.45	-	9.10	-	-	-	12.55
Total time outage in each months	23.29	3.57	11.01	20.43	4.19	4.06	14.21	1.51	14.09	36.26	9.18	1.42	151.06

2006-2007). The faults are indicated by various symbols, they are A,B,C,D and E as shown in Table 1 and also various meaning of each symbols. The monthly types of faults documentation are shown in Table 2 and the monthly time outage due to different types of faults is shown in Table 3.

RESULTS AND DISCUSSION

The different faults associated with electric power transmission line have been considered. The result shows that the occurrence of these faults varies with climatic conditions and environmental factors.

The fault analysis chart Fig. 8 shows that fault A has the highest occurrence which is 34 from Table 2. Fault A are faults base on outage, to enable the (PHCN) staff work on the 132 KV transmission line, to replenish the circuit breaker with gas, replacement of cross-arm, isolators, poles and any fault equipment.

Figure 9 shows that the month of January has the highest faults. The reason is that this month usually witnesses high bush burning leading to burnt poles, cracking of porcelain insulators, carbon particles in the smoke do short-circuit the conductor and may bridge the conductors to ground and damage of other power supply equipment.

The second highest faults in Fig. 9 were recorded in September when the rainy season is setting out. During at this time, there is more increase in lighting, strong winds and thunders storms which make the distribution network highly vulnerable to faults.

Figure 10 shows that the month of October has the highest time duration outage. The reason is that this month usually witnesses replacement of damage equipment from the passed rainy season resulting from lighting, strong wind, etc. this led to frequent power outage in that particular month. The second highest time duration outage was recorded in July this is due to heavy rainfall in the month of July resulting from short-circuit, lightning problem, cracking of insulator etc.

The research indicates the period that each fault is most likely to occur and how these faults can be prevented.

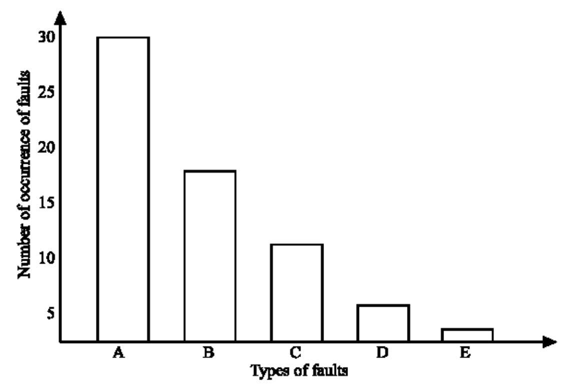

Fig. 8: The bar chart of fault frequency

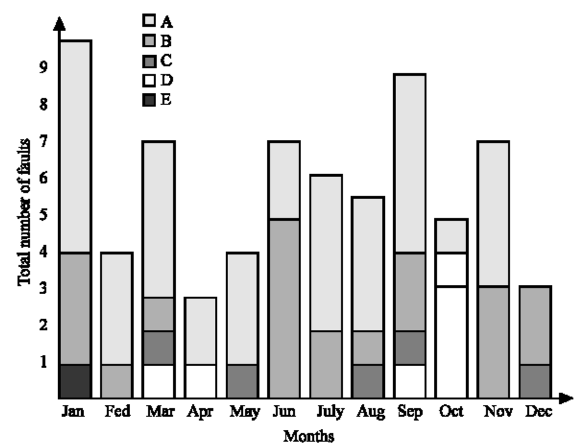

Fig. 9: Component bar chart of each months and types of fault

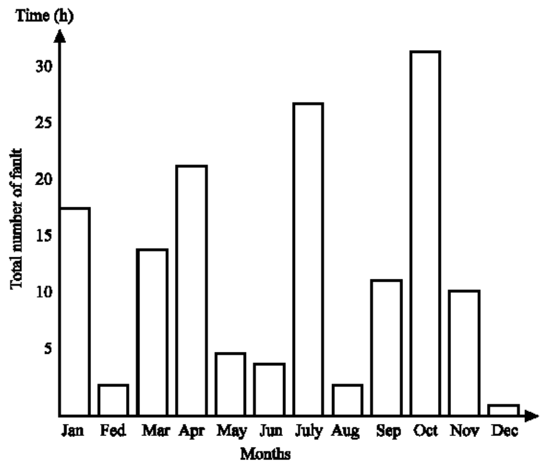

Fig. 10: Bar chart of time duration outage of variou months

CONCLUSION AND SUGGESTIONS

Faults occurrence has been investigated in power distribution network, 132 KV Benin-Irrua transmission line between July 2006 to June 2007, a total of 71 faults occurred in 132 KV Benin to Irrua transmission line that led to the interruption of power supply to consumers in Ubiaja, Agenebode and Uzebba feeders. Fault A has the highest occurrence. The total time duration outage in a year is 151 h. 06 min. This is refered to as down time of power supply along Benin-Irrua 132 KV transmission line.

The analysis showed that the month of January has the highest faults in a year. This was closely followed by September as shown in Fig. 9. The month of October have the highest time duration outage on the bar chart on Fig. 10 therefore we suggest that:

- All fault equipments or component such as cross arms, cracked insulators, circuit breaker etc should be replaced on time.
- The supply authority (PHCN) should put contingency plan in place to reduce the fault level at that particular month of the year.
- Replacement of faulty components or equipment before the rainy season sets in.
- As a matter of urgency, another feeder should be created from Benin-Irrua region.
- Proper vegetation management to reduce the problem of short-circuit and earth faults also animal guard should be provided on towers to prevent short-circuit and open-circuits.

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