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# THE EFFECT OF FAULTS UNDER DEREGULATED POWER SYSTEM

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## ABSTRACT

In this paper, the analysis of faults under deregulated power system is emphasized Vis-a-Vis as it affects the power system parameters. The interactive power system analysis (IPSA) program is employed and taken in two parts, deregulated system under fault and fault under deregulated system. Faults that occur in any power system are the same whether the system is regulated or deregulated. The three phase fault is analyzed although it rarely occurs, others are line-to-line, line-to line-earth and line-to- earth faults, all known as unsymmetrical faults. From the simulation analysis, fault currents are higher and voltage drops on lines are reduced. However, in a deregulated power system, the responsibility for fault management and control is decentralized. Also deregulated are the various units, generation, transmission and distribution. The resultant effect is that the entire system is better equipped for real-time enhanced fault localization and isolation in the event of fault occurrence. And this gives rooms for investors to come in.

**Keyword:** *symmetrical faults, unsymmetrical faults, open conductor faults. Failure of insulation, thermal failure*.

## INTRODUCTION

Essentially, before any power system can be successfully deregulated, three organs of control have to be established. First, electricity regulatory authority, a power transmission company and independent system operator (ISO). The electricity regulatory authority is saddle with the responsibility of development and enforcement of power grid operating codes and standard as it relates to generation, transmission, distribution and marketing of electricity. The power transmission company, function is to ensure that the power generated at the generating station is transmitted through its transmission network to various point of power distribution to consumers. The power transmission company is usually owned by the state and operated on her behalf by private entities. This is to ensure that the transmission grid is evenly developed and power is transmitted to all states irrespective of their industrial status. The independent system operator (ISO) is needed to coordinates the operational activities of the various players in the system towards attainment of system reliability, availability and efficiency. The independent system operator must have the facilities that enable her to see and control (in real time) the various switching operations and power flows at major points and nodes of the entire grid network. An enabling economic and social environment that guarantees the security of investors fund should be also put in place. It is highly impossible to design a fault proof power system, as it is neither practical nor economical. Modern power system constructed with high insulation level are economically practical, have sufficient flexibility so that one or more components may be out of service with a minimum interruption of service. Fault occurs principally due to failure of insulation, electrical, mechanical and thermal failures. Faults are classified into three categories, namely, symmetrical, unsymmetrical and open conductor faults. Symmetrical fault are, three- phase fault, three- phase fault to ground.

Unsymmetrical fault are, phase-to –phase, two phases to ground and single –phase to ground. While open conductor faults are, one-phase broken wire and two phase broken wire. These faults cause damages to lives, properties and equipment and as such it has to be cleared as fast as possible. A comparator methodology is employed between two generators in a six- bus bar system. Three phase fault and line to ground was simulated using interactive power system analysis (IPSA).

**LITERATURE REVIEW**

Power distribution business commenced in Nigeria in early 1900 when the first generator was fixed at Lagos by the then public works department. This metamorphosed to the Electricity Corporation of Nigeria (ECN) in 1950 which has isolated undertaking cutting across the nation. The ECN was later merged with the Niger Dams Authority, NDA which manages the hydro potentials of the River Niger that gave birth to the defunct National Electric power Authority in 1972. The creation of NEPA entrusted the duty of generation, transmission, distribution and sales of electricity to a single entity throughout Nigeria. Over time, the inherent inadequacies of a public monopoly necessitated government to not only commercialize NEPA but to repeal the act establishing it and commenced fully the road map to the full privatization of this most important sector of our economy.

**METHODOLOGY**

The method adopted in this research work is the conventional model of synchronous generator for both centralized (on slack bus) and generator 2 (on P & Q BUS). They were both modeled as a Thevenin's equivalent circuit (voltage source and series impedance). A test bed system was used to calculate fault current with and without generator 2. A test bed is a six-bus system with eight distribution line and sixteen circuit breakers. Per unit bases for the problem are 25MVA and 12KV.a 5-MW generator with equal positive and negative sequence reactance each of value 0.9p.u and a zero sequence reactance of 0.3p.u were installed at bus 6. These formed part of the synchronous, transient and sub-transient primary data. Interactive power system analysis (IPSA) and a fault reactance of 0.11p.u on a common base of 25MVA with maximum fault iteration set at 5. Balance three-phase fault and line-to-ground fault were simulated, and the result recorded form part of the secondary data. The results are as presented in tables 1-4

Table.1: Line properties (on a common base of 25MVA and 12kV)

| **From** | **To** | **R (p.u)** | **X (p.u)** | **$R_0$ (p.u)** | **$X_0$ (p.u)** |
|---|---|---|---|---|---|
| Busbar 1 | Busbar 2 | 0.0323 | 0.0761 | 0.0244 | 0.07135 |
| Busbar 1 | Busbar 3 | 0.03525 | 0.0830 | 0.0267 | 0.0778 |
| Busbar 2 | Busbar 4 | 0.0206 | 0.0484 | 0.0156 | 0.0454 |
| Busbar 3 | Busbar 4 | 0.0646 | 0.01522 | 0.0489 | 0.1427 |
| Busbar 3 | Busbar 5 | 0.0441 | 0.1038 | 0.0333 | 0.0973 |
| Busbar 4 | Busbar 5 | 0.0558 | 0.1314 | 0.0422 | 0.1232 |
| Busbar 4 | Busbar 6 | 0.0162 | 0.0380 | 0.0122 | 0.0357 |
| Busbar 5 | Busbar 6 | 0.0411 | 0.0968 | 0.0311 | 0.0908 |

R = Resistance, X = Reactance, $R_o$ = Zero Sequence Resistance
$X_O$ = Zero Sequence Reactance
The line properties on a common base of 25MVA and 12kV are shown in the table above.

Table 2: balance 3-phase fault

| Faulted bus | $I_f$ (kA) without generator 2 | $I_f$ (kA) with generator 2 | $I_f$ (kA) difference |
|---|---|---|---|
| Busbar 1 | 7.245 | 7.387 | 0.142 |
| Busbar 2 | 6.726 | 6.890 | 0.164 |
| Busbar 3 | 6.704 | 6.880 | 0.176 |
| Busbar 4 | 6.658 | 6.848 | 0.190 |
| Busbar 5 | 6.369 | 6.551 | 0.182 |
| Busbar 6 | 6.412 | 6.626 | 0.214 |

Figure 2.1: balance 3-phase fault

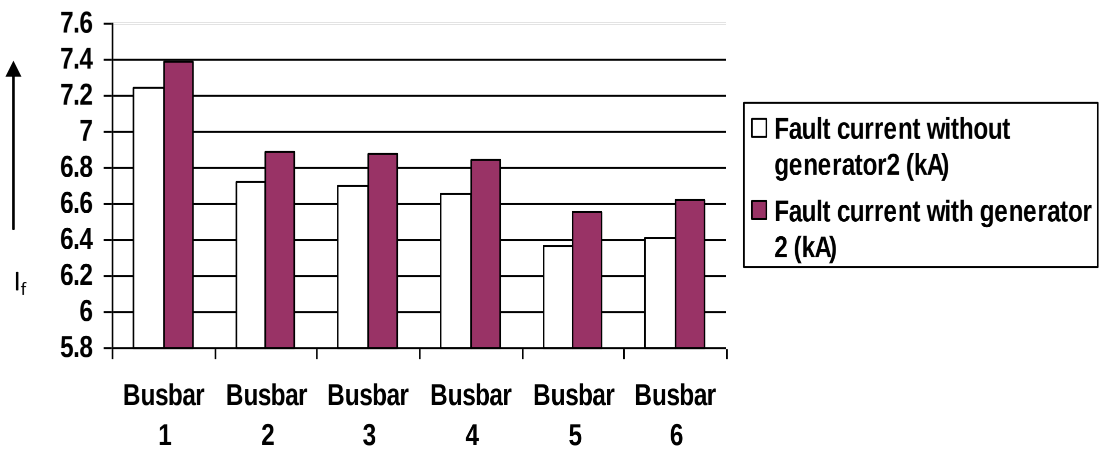



Table3: Line-to-ground fault (on red phase)

| Faulted bus | $I_f$ (kA) without generator 2 | $I_f$ (kA) with generator 2 | $I_f$ (kA) difference |
|---|---|---|---|
| Busbar 1 | 8.137 | 8.256 | 0.119 |
| Busbar 2 | 7.465 | 7.604 | 0.139 |
| Busbar 3 | 7.432 | 7.579 | 0.147 |
| Busbar 4 | 7.326 | 7.491 | 0.165 |
| Busbar 5 | 7.055 | 7.215 | 0.160 |
| Busbar 6 | 7.061 | 7.257 | 0.196 |

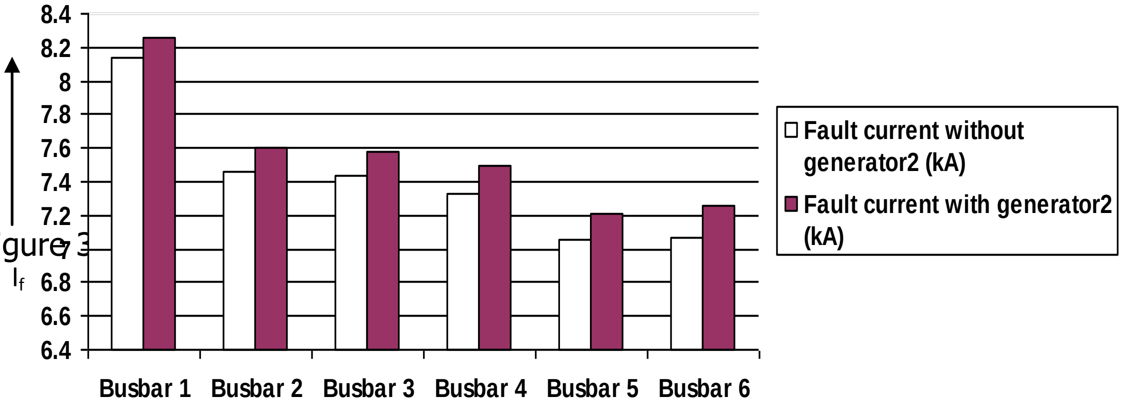



Figure 3

Table 4: Voltage drop results

| **Busbar** | **Voltage drop Magnitude (V) without generator 2** | **Voltage drop Magnitude (V) with generator2** | **Drop** |
|---|---|---|---|
| Bus 1-2 | 33 | 21 | 12 |
| Bus 2-4 | 14 | 7 | 7 |
| Bus 1-3 | 29 | 20 | 9 |
| Bus 3-5 | 16 | 7 | 9 |
| Bus 5-6 | 4 | 4 | 0 |
| Bus 4-6 | 2 | 5 | -3 |
| Bus 4-5 | 2 | 1 | 1 |
| Bus 3-4 | 18 | 8 | 10 |

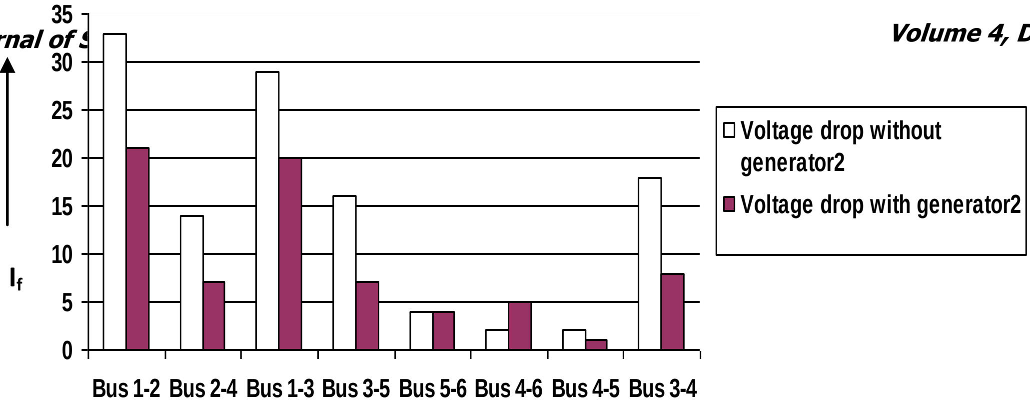
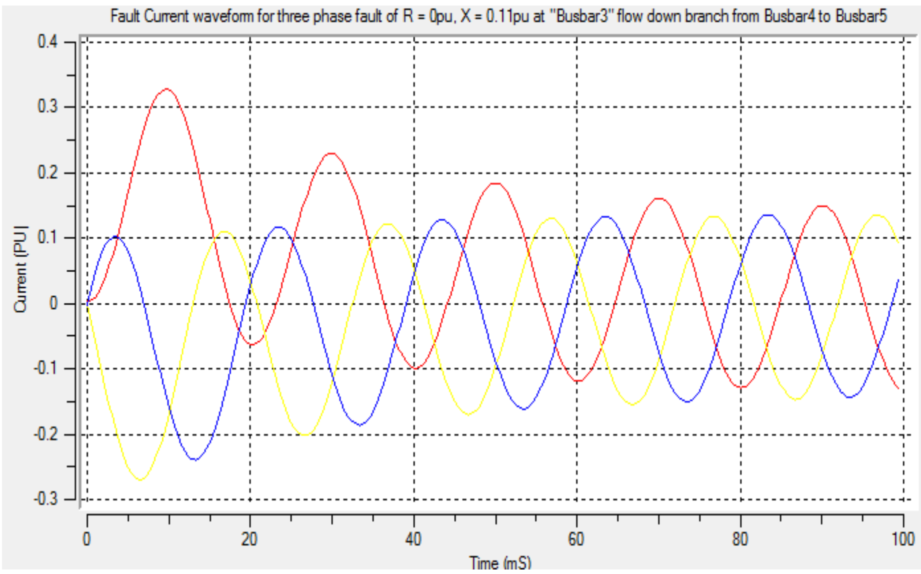
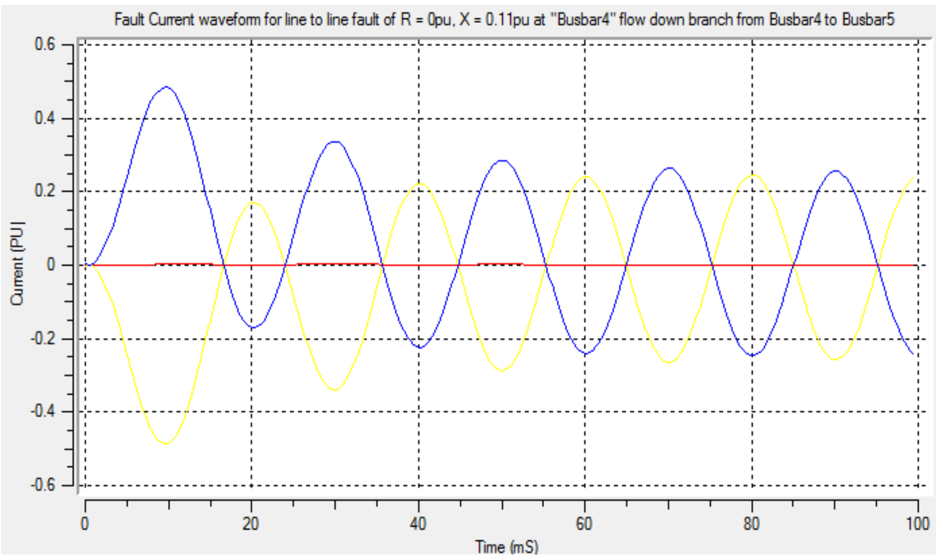



Figure 4.3: Voltage drop chart

Graph 1




Graph 2



## ANALYSIS OF RESULTS AND SIMULATION

Results presented in table 1- 4 above were analysis and simulated. In the simulation, the following standard assumptions were made:

- The waveform plots for both types of faults, the fault current is assumed to flow from bus 4 to bus 5, and the distance along the branch for the fault is assumed to be 44%.
- In the voltage drop simulation, a high load of 4MW with power factor of 0.95 lagging is assumed at bus 4.
- All other parameters remained the same.

## DISCUSSION OF RESULTS

The introduction of generator 2 increases the fault current ($I_f$) for both balance three – phase fault and line – to – ground fault. The fault current increases because of reduction of the Thevenin impedance at the bus where generator is connection. The voltage drop decreased significantly with the connection of generator 2. In the waveform graph for, balance three – phase faults, the fault currents all have the same magnitude but they are $120^0$ apart. The Red, yellow and the blue phase current patterns are not symmetrical about the time axis. The maximum fault current at the red phase decreases with time. In the yellow and blue phase, it increases with time. However, the peaks –to-peak current remains the same. In the line – to- ground fault, the waveform graph is sloping downwards and the maximum current in the red phase decreases with time. A fault current in power systems determines the ratings of circuit interrupting devices and settings of power system protection relays. In essence if the fault current is higher than the previous interrupting capability of the circuit breaker, the fault current, if persist can cause damage to personnel and equipment. In view of the above the following points are hereby suggested to the would be investors for effective management of the deregulated power system.

1) Fault management is relatively high; to achieve these experience technical personnel should be brought on board.
2) Adequate security over destruction of equipment should be provided, in order to reduce artificial fault caused by vandals.
3) Indiscriminate generation into the grid system should be checked. This is to enhance system reliability and continuity.
4) Good protective devices should be used in installations, in order to improve the system.
5) The response time for fault clearance should be fast, so as to restore supply to consumers as soon as possible.
6) There should be a network of gas pipeline across the country to facilitate the erection of gas –fired generating turbines at some designated heavy load centers.

## RECOMMENDATIONS TO CONSUMERS

1) Consumer will have to pay much higher than they are presently paying for electricity.
2) Consumers should learn how to conserve energy and also build more energy efficient homes

## CONCLUSION

Some of the results achieved in this paper shows that in a deregulated system, with the installations of more generators the fault current increases and this required high and more expensive protective devices to be put in place for reliability and continuity of the system. This research works also provide tremendous insight of the benefits of a deregulated system to consumers. Consumers will only have to pay for what they consumed. This eliminates the issues of estimated bills. Consumers will have better option since, the monopoly is no more and the industry is now competitive, more jobs will be created in the power industry. If the capacities that are already in placed are improved upon and manage efficiently there would be a huge revenue gain for investors.

## REFERENCES

Nagrath, I.J and D.P. Kothari: modern power system Analysis, 2nd edition, Tata Mc Graw – Hill, New Delhi, 1989.

Stevenson, W.D Element of power system Analysis, 3rd edition, Mc Graw- Hill Kogakusha Ltd. Tokyo, 1975.

Wood, A.J and B.F. Wollenbergi power Generation operation and control, John Willy, 1996.

Faulty study, analysis and short – circuit calculations by Mr. L.A Noronha of PHCN, august 2007.

Interactive power system analysis (IPSA) program. WWW.IPSA- power.com/software 2008 version.

Power distribution in a developing country – a Nigeria perspective paper delivered by Engr. E .O. I Ikwu, august 2007.