RELIABILITY AND MAINTAINABILITY ANALYSIS OF NEPA 11KV DISTRIBUTION NETWORK WITHIN MINNA METROPOLIS

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ATTESTATION

I do hereby declare that he work presented in this dissertation was carried out solely by me in lieu of the partial fulfillment of the requirement of the Department of Electrical and Computer Engineering, Federal University of Technology, Minna, Niger State for the award of BACHELOR OF ENGINEERING in the department.

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DEDICATION

This work is dedicated to my late father Mallam AHMED RUFAI NDAGI, my mother and all others that have been encouraging and supporting me, concerning my academic education.

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I, am sincerely grateful to the almighty Allah for giving my klife a good health throughout my stay in this institution. This unmerited favour, guidance, faithfulness and hope I enjoyed from Allah, was immeasurable, hence my appreciation.

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ABSTRACT

The objective of this project is to analyze the reliability and maintainability of NEPA 11KV distribution network of Minna metropolis. The network consists of five feeders (11KV) and six inter-connected buses.

The theory of reliability and maintainability has been discussed. The feeder failure rate, repair time, transformer failure rate, and replacement time of transformer etc as used to obtain the reliability and maintainability of each feeder. Also a computer software program is designed using the well known BASIC HIGH-LEVEL LANGUAGE to calculate reliability indices of a feeder.

The results obtained are analyzed and recommendations on how the system network can be improved are given.

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CHAPTER ONE

1.1 INTRODUCTION

Reliability is the ability of electrical installation to carry out its desired function in the time framed required for it to work with all it technical parameters in the required limits. Reliability is commonly accepted to mean the confidence the user has in his operation, reliability of service generally is interested to mean the continuing of service or lack of interruption to service.

The study of reliability needs a combination of electrical engineering (for system analysis, statistics for the analysis of failure data) and probability theory for the prediction of failure pattern) Reliability assessment is usually developed from the failure rate method. This method is based upon the assumption that system failure are reflection of component failures and the that beyond the burn in and wear out failure regions component failure are random and failure rate is constant with respect to time, the aim of any electric power utility company is to supply reliable power of acceptable quality at reduced cost. Such a system would consist of generating, the transmission and the distribution unit. The reliability and adequacy of the whole system is therefore dependent on the reliabilities and adequacy of each unit. Hence, the reliability is and always has been one of the major factors in the planning, design, operation and maintenance of electric power system.

In mathematic sense, reliability is generally characterized or measured by the probability that an entity can perform one or several required functions under given conditions for a given time interval.

In the strictest sense of the word, reliability was defined in the 1970s as the ability of an item to perform a required function under stated conditions for a stated period of time. By the International Electro Technical Commission (IEC 271, 1976). The last definition given by International Organization (IEC 50 (191) 1991) is Quite similar, the ability an entity to perform a required function under a given conditions for, a given time interval.

1.2 THE CONCEPT OF RELIABILITY ANALYSIS

1.2.1 IMPORTACE OF RELIABILITY ANALYSIS

The reliability of a system is very important because if there is reliability all the work can be controlled and any failure happen can be detected and be repaired without waste of time, reliability allowed Engineers to control a system as well as conserve it.

Also the importance of reliability is to play economic and social life of people, because the failure for any functional item or technology project can cause fundamental loss, can cause human frustration and dissatisfaction, and in the ultimate, can cause death. Reliability of electricity supply will prevent operational and safety embarrassment.

Failure of electricity supply to consumer may lead to damage or destruction of electronic device and money is spent every time. So as said, the need of getting reliable current is for safety and cost.

1.2.2 WAYS OF ANALYSIS RELIABILITY OF A SYSTEM

Reliability can be analysed in two (2) ways. One Reliability can be analysed as the mean number of failure in a given time (failure rate) or as a mean time between failures (M.T.B.F). A useful measure of performance which does not involve the period of observation is the mean time between failure (MTBF). The (MTBF) in of a system may be measured by testing it for a total period during which N faults occur. Each fault is required occur. Each fault is repaired and the equipment, the repaired time bring excluded from the total test time, T, the observe MTBF is given by

$$M = \frac{T}{N}$$

Another way of expressing equipment reliability is the failure rate, that is the number of failure rate per unit time. For many electrical system. The failure rate is approximately constant for much of the working life of the equipment. Thus the failure is the reasoned of the MTBF

$\lambda = 1/M$

M is usually expressed in hour ~~so~~ that the corresponding units are fault per hour.But for the item that can not be repaired example are thermonic values, resistor, capacity the correct measured for these component is mean time to fail (MTTF) let a set of Nitems be tested unit all have failed the time to failure being t_1, t_2, t_2

Then the observed MTTF is given by expression

$M = 1/n \sum_{i=1}^{n} i$

$\lambda = 1/M$

λ In this case depend on time

1.2.3 RELIABILITY AND HAZARD FUNCTION

In reliability, engineering interest is in the probability that an item will survive for a stated interval (e.g. time cycle distance e.t.c) This implies that there is no failure in the interval (0 to X). This represent S reliability. This is given by reliability function R (x).

Define as

$R(X) = 1 - F(X)$

$$\int_{-\infty}^{x} F(x)\, dx = 1 - \int_{-\infty}^{x} F(x)\, dx \quad \text{..(1)}$$

The hazard function or hazard rate h (x) is the conditional probability of failure interval x to (x + dx). Given that there was no failure by x

$$H(x) = H(x) = F(X)/R(X) = F(X)/1\text{-}F(X) \quad \text{........................(2)}$$

The commutative hazard function H (x) is given by

$$H(X) = \int_{-\infty}^{x} H(X)\, dX = \int_{-\infty}^{x} F(X)/1\text{-}F(X)\, dX \text{:.......................................(3)}$$

1.2.4 RELIABILITY IN TIME DOMAIN

If in a time domain application. N failure occur in some total time of interest T, then it is necessary to know the probability of failure as some function of N and the T let the total time T to be considered to be made up of n equal increment of time St. (δt).

The time increment . (δt) needs to be chosen so that any increment contains either no failure or not more than one failure. Each increment of may be looked upon as bring either successful or a failed event. The probability of any time increment of being classified as failure event is Pt = Limit/n ∞ = M/n ……………….(1).

Since both T and N are finite, then P tends to zero as n tends to, infinity, that is as St tends to zero. This is an expected result as there is zero probability of failure occurring in an infinities period. However, there is obviously some finite probability of failure related to the Total time T and this may be deduced by considering the limiting combination of the probabilities of failure for each increment of the combined probability p_t of at least on failure occurring in the total time T is made up of probability of a failure occurring in any or more of the increments of time ft.

From the general expression for independed event which are not mutually exclusive. $P(A_1 + A_2 + \ldots\ldots A_K) = 1 - P(A_1 A_2 \ldots\ldots\ldots\ldots A_k)$ ……………….2

Then

PT = 1 – Limit/n - ∞(1 – N/n) Provided that

The value of P_t and hence of N can be take as being constant and time independent relative to the position of any time increment ft in the complete range. T Applying the exponential limit theorem, then equation (20) above is reduce to $P_t = 1 = 1 - e^{N}$.

Then a mean failure rate parameter λ such that $\lambda = N/T$

$P_t = 1 - e^{-\lambda t}$

An aspect of reliability of time domain arise however, where there is a need to ascribe some measure to the availability or unavailability of a junction object. This concept become important as it concern maintenance repair time. Restoring or replacing the failed item

1.3 MAINTAINABILITY CONCEPT

Maintainability is an index of Reliability which serve to predict and observe/fix the reason which might be behind a fault or failure (under the working condition of an electrical installation with the aim of removing the causes by repair works or technical services.

A system is maintained when it is repaired when it fails and work is performed on it to keep it operating. The ease with which repair or other maintenance work can be carried out determines a system maintainability. Maintainability can be quantified as the mean time to repair (MTTR).

(MTTR) The time to repair however included serve activities usually divided into three groups:

(1) Preparation time: Finding the person for the job, travel, obtaining tools and test equipment.

(2) Active maintenance time: actual time spent in localizing the faulty.

(3) Delay time (logistic time) Waiting for spare e.t.c. once the job has been started.

Active maintenance time includes time for studying repair chart circuit diagrams before the actual repair is started and time spent in verifying that the repair documentation when this must be complete before the equipments can be made available e.g. on

Maintainability is often specific as a mean active maintenance time (MAMT) since it is only the factional time 9excluding documentation) that the designer can influence to achieve a high level of reliability, that is approaching unit the (MTTR) value must be low and this implies that the system can be maintained relatively easily. Maintainability is one of the parameter which contributes to product/service availability. It is broadly defined as the case of restoration of service after failure and is expressed in any of several "figures of merit" the most usual being-time to repair (MTTR) Unavailability due to breakdown.

The major aim of a general maintenance of Electrical power distribution network is both to minimize the occurrence of failures and to ensure that in case of failure, the right person can be sent to the right place with the right equipment at the right time to perform the right action.

The maintenance is very important because. It restore the reliability and availability of physical asset as much as possible also gives assurance that the equipment is safe touse, it reduces the breakdown.

1.3.1 WAYS OF ANALYZING MAINTAINABILITY OF SYSTEM

Maintainability is defined as the probability that a system that has failed will be restored to a full working condition within a given time period. The mean time to repair, the rate(μ) is measures of maintainability.

$$\mu = 1/MTTR$$

and maintainability $M(t) = 1 - e^{-\mu t} = 1 - e^{-t/MTTR}$

where t is the time allowed for the maintenance action.

1.3.2 GENERAL ANALYSIS OF MAINTAINABILITY AND RELIABILITY

A close relationship exists between reliability and maintainability one affecting the other because well maintenance leads to high reliability of the system and both maintainability and reliability affect availability and cost. In the steady sate i.e. after any transient behaviour has settled down and assuming that maintenance, action occurs at a constant rate:

Availability = MTBE /MTTR + mean preventive maintenance time

Thus the maintainability of a system is clearly governed by the design and determines features such as accessibility, ease of test and diagnosis, and requirement for calibration. Lubrication and other preventive maintenance actions.

Chapter one and two provide the basic ideas on the reliability and maintainability analysis. Chapter three is the case study of Reliability and maintainability analysis of 11KV power system within Minna metropolis and chapter four and five explain the Recommendation and conclusion.

1.4 AIM AND OBJECTIVE OF THE PROJECT

Since the task of electricity supply is to reach the consumer end (point load) regardless of the uses, with high quality and as economical as possible. This project is designed to develop a software program to analyze critically using some distribution reliability indices e.g. failure rate, annual availability e.t.c. the available projection system and the network configuration in conjunction with statistical data on the like hood fault occurrence will be used to estimate overall reliability of supply of consumers. And also the project will analyses maintainability of distribution network, it will be useful to engineer in designing new or improving the existing ones.

CHAPTER TWO

2.1 LITERATURE REVIEW

Ever since man first made objects these were faced with the problems of, unreliability, shoes were out, spears broke bridge collapsed. Improvement were made partly by trial and error and partly by a simple process of analysis and re-design. On when a reliability assessment was made by Lusser was it realized that a system relying on many component parts was like a chain with many links. Since failure of any link causes failure of the whole chain it is thus necessary for each individual link to be highly reliable if the complete chain is to be reliable.

Prior to the 1939-45 war relatively little attention was given to the reliability of Electrical equipment. Most of the apparatus were simple and contained few components. Equipment was used mostly in favorable environment without excessive heat, vibration or humidity. During the war, equipment was require to stand desert heat, extreme cold and high humidity and it became technically much more advanced and more complicated. Such factors increased the chances of failure it become essential to study and improve reliability.

So that equipment made would perform satisfactorily for long periods, the cost to repair and maintain equipment raised up to about ten times become necessary in its definition to specify the electrical and electromagnetic situation, the temperature and its variation the climatic conditions such as salt spray, ice formation, dust storm, humidity, mechanical conditions such as the frequency and amplitude of vibration. The electrical environment include the full range of input signal and interference the variation of supply voltage, and the size of any switching transients. Together with the variation of output load it this is relevant. The electromagnetic environment is important if the equipment is to operate near other unit which generate large electromagnetic fields. For space and nuclear – rector electronics, one may need to specify the level of radiation or the total integrated dose which the equipment may be exposed.

Immediately after the 1939 – 45 war, little development of reliability theory took place. However, during the Koran war of 1950 – 1953 the USA found that the availability of its fighting aircraft was disastrously low, largely owing to the unreliability of the Avionics. More and more of which was being carried by the aircraft. Thereafter the US military authorities made a determined and largely successful attempt to build a thorough understanding of reliability theory and practice.

The pace of understanding of reliability principles increased during the 1960s. This grew from the realization that although reliability is an important system parameter, some wider method was needed for assessing the "goodness" of several different completing system.

The study of reliability is now well established. Journals dealing with reliability topics (micro electronics and Reliability in the UK, IEEE Transaction on Reliability in the USA) are published regularly, many conferences are held, chiefly) the Annual symposium on Reliability in the USA and the biennial Reliability Conference organized in UK by the NCSR and IQA.

On the whole, system reliability can reasonably be considered to have shown steady improvement over the last 30 years, especially when the increased complexity of most system is taken in to account. Nevertheless the achievement of effort in this direction can be disastrous as shown by the failure of the challenger shuttle in 1986. The twin field of Reliability and maintainability are likely to be those to which manufactures of components or systems must pay increasing attention if they are survive the competitive pressures of the 21st century.

Increasing customer sophistication and awareness of important of reliability means that only those manufacturers who are dedicated to the higher produce standard survive in an increasing competitive world.

2.2 RELIABILITY OF POWER SYSTEM

The reliability of a power system is a way of measuring the capacity of that power system in serving all power demands made by all customers without failure over long periods of time.

The aim of any electric power utility company is to supply a reliable power of acceptable quality at reduced cost such a system will consist of the generating, the transmission, and the distribution unit. The reliability and adequacy of whole system is therefore dependent on the reliability and adequacy of each unit. Hence, the reliability is, and always has been one o major factors in the planning, design, operation and maintenance of electric power system.

The distribution network is usually at the national level and principal criterion of interest is the resulting overall reliability of the system. Obviously, its service is bring offered to a customer then overall cost of a power system and its availability are of prime important. As a power station tend to become larger, then often there is tendency for the power station not to be cited at the points of bulk load and transmission cost and associated reliability can be progressively more important. Larger capital expenditure is involved in such electrical supply system and the loss of electrical supplies to many customer can be very much more than just an economic embarrassment. In some application, it can also lead to the risk of human life. Once again there arises the basic ingredients for high-risk situation and the need for high reliable system.

2.2.1 DEGREE OF ELECTRIC POWER SERVICE RELIABILITY

As a practical matter, all consumers may not require a uniformly high degree of service reliability for some consumers, an extremely high degree of service is essential, these may include hospitals, military establishments some larger theaters, department stores, apartment building, hotels e.t.c. where the safety of public is concerned power outage is accompanied by danger to the people (life of humans), damage to economy, stoppage of complex engineering processing the those areas. often auxiliary sources of supply are provided to supplement the utility company supply.

For some other types of loads, a high degree of reliability is desirable but not so essential from the public safety viewpoints, smaller apartments and theaters are examples of these, as well as some manufacturing or service are examples of these, as well as some manufacturing or service processes where interruption may result in substantial monetary loses, idleness of workers, massive non-production of industrial product. however, a short interruption (and in some cases even or an occasional long one) is more of an inconvenience than a hazard or cause for monetary loss.

As a rule, provision for higher degree of service reliability involve higher expenditure for both additional facilities and increased maintenance. The expenditure to provide reliability should bear some proportion to the degree of reliability needed various system design, provided for varying degrees of service reliability, from a simple unsectionalized radial feeder to a low-voltage secondary network supplied from multiplicity of primary feeder isolated from each other. Each type of service should produce revenue to justify the additional expenditure for achieving the service reliability desired or required. exception may be made for such public services as hospital and military establishment.

2.2.2. MAIN CAUSES OF FAULT IN POWER SUPPLY

The main causes of failure that eventually lead to power failure are (i) Earth fault (ii) short-circuit (iii) Open circuit. These faults in one way or the other result in excess current or other disturbance in the supply network.

The other causes of faults in power system are: (i) Over loading of component e.g. in transformers circuit breakers e.t.c. (ii) ageing of components (iii) lightening strike (iv) bird or animal contact (v) conductors swinging together (iv) faulty equipment of load from load centres and so on.

All these result in low power supply. Fault can also in power system when there is broken poles, fallen or leaning of poles, broken cross arms action of vehicle.

2.2.2 WAYS TO IMPROVE THE RELIABILITY OF POWER SYSTEM

The concept of reliability has to be associated in a qualitative way with good design of equipment endurance, consistent quality and dependability. Also efficient preventive maintenance and corrective maintenance must be carried out always, additionally:-

i) Reliability Studies of the entire installations in the grid including the communication system should be coordinated.

ii) Property scheduled and prolong routine maintenance should be regularly carried out.

iii) Catastrophic faults can be greatly minimized if diagnosed trouble shooting and repairs of incipient faults are embarked upon immediately a fault indication is sensed.

iv) Regular up-date training of operators and engineers in the filed will enclose their effectiveness. They will come to understand the system better and to inform the attention of management and suspected operation sequences of major equipment before their ma-operations become sources of embarrassment to the authority.

v) Alternative arrangement of the station equipment (or spare part) can be desired to ensure maximum availability of units. Through prompt replacement of faulty equipment to source when necessary.

vi) The management of power station should be more knowledgeable about. The subject of reliability. Furthermore an achievement of high reliability performance should be recognized as one of the co-operate objective demanding top management attention.

A standard method of data recording which gives enough information should be adopted. This may further use in planning, maintenance and operation.

vii) In order to prolong the life of the units the generating units should not be run at full capacity.

viii) The station's alarm relay and repairs and other indicator need to be regularly rested and calibrated to ensure that they are functioning adequately.

2.3 RELIABILITY ALGORITHM OF LARGE NODE WEIGHT NETWORK

If analysis aim is to assess important of power plan and electric substation in electric power network damage of transmission can be neglected. Therefore, the electric power system may be regarded as nods weight net work system which node weight denote seismic reliability of power plans and electric sub-stations. In reliability computation a larger scale node weight networks, these are two problems involving including space complexity and time complexity, therefore, analysis of the problem become much more easy.

Assumption L_i and He made are:

1. Nodes failure is S – independent

2 System and its node have two states; operative and failure from the liaises or fundamental, definitely an arbitrary smallest minimal path from the source to terminal of a network system are:

$L_0 = (S_1, S_2, 53 \ldots\ldots\ldots\ldots S_{s0l})$ where S_{li} = 1,2 … Isol are nodes or edge of the system, (S_o) is the number of component making up $/S_o/$

They made system structure system to be function

They made system structure system to be function O(G), then using absorption law, that is

$\theta G = L_o + L\theta G \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$ (1)

According to de Morgan law there exist

$\theta G = L_o + /S/ \theta (G) + (S_1, S_2) \theta G_2 + \ldots\ldots + (S_1 S_2 \ldots S_1) \theta (G_1) +\#$

$(S_1 S_2 \ldots\ldots S_i \ldots\ldots S/sol) \theta G/sol \ldots\ldots$ (2)

where G_i is a subdivision received through detecting component S_i Eho from original G

If sub-graph G_i I = 1,2 ……. (S) in equation (3) still has minimal path S_i, I = 1,2…… $/s_i/$ from the source to terminate and making C_i to be responding co-efficient term in front of $\theta(G_i)$ and is named decomposition factor then the equation can be transformed to as

$\theta (G) = L_o$

$$Ø = L_O + \sum_{i=1}^{/S/} C_i /S/ + \sum_{j=1}^{/S/} C_i /S/ Ø (G_i) \ldots\ldots\ldots\ldots \quad (3)$$

Where S_i is decomposed according to eqn (2)

Then there are /So/ - $/S_i/$ sub-graphs G_i = j = 1,2 ……

/So/ - $/S_1/$ in eqn (3) that do not have mini paths from the source to the terminal they also made F_j to be the responding co-efficient term in front of OG_j then according to complementation.

$$Ø(G) = 1 - Ø(C) = \sum_{i=1}^{S} F_i + Q$$

Where Ø (G) is a failure function of the system, Q is the remaining term According to the above principles eqn (3) can be continually recursively decomposed until all generated sub-graphs do not exist any minimal paths from the source to the terminal, then there exist.

$$Ø(G) = L_0 + \sum C_i \bar{S}_i + \sum + \ldots\ldots + \sum C_i S_i \ldots\ldots (5)$$
$$= \sum_{i=0}^{N} L_i$$

Where N is the total number of disjointed minimal paths, $L_i = CISI$ is the i. The design minimal path of original system G.

The integrated form of Equation 4 can be obtain as follows

$$ØG = \sum_{J=1}^{M} F_J \ldots\ldots (6)$$

Where F_j is the disjoin minimal cut of the system G,M is the total number of disjoin minimal cuts.

According to Equation (6), reliability system is

$$R(G) = \sum_{i=1}^{N} P_K(L_i) \ldots\ldots 7$$

$$P_K(L_i) = \prod_{i=1}^{N} (1 - P_i) \cdot \prod_{i=N+1}^{N_i+1} \ldots\ldots 8$$

Where P_i is the reliability of i -the component is net work system G_i. N_i is the number of failure component in L_i. K_i is the number of operative component in h_i.

Meanwhile failure reliability of the system is as follows

$R(G) = \sum P_F(F_j)$

Where M_j is the number of failure component in F. K_j is the number of operative component in F_j

It was concluded from the paper presented by Jie Jun 2002 that: Infact, a recursive decomposition algorithm for system seismic reliability estimation of electric power system with the aim at solving space complexity in analysis of system reliability. Because categoricalness of structure function is not destroyed during copulation all avoid getting fake elementary path during calculation of node weight system seismic reliability accurate value of system seismic reliability can be evaluate than ever.

2.4 THEORY OF MAINTAINABILITY

Maintainability has two objectives purposes and Economics.

(a) Purpose: Maintenance philosophy should be accomplished. Additionally, for a defined level of service the total cost should be kept to a minimum by the use of appropriate method e.g. centralized operation and maintenance.

(b) Economic, the operation and maintenance functions in a network should be planned in such a way that the life cost will be minimum. For a defined level of service no total cost consists of investment maintenance and cost for loss of traffic.

1) **Prevention maintenance**: Is the maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item. Preventive maintenance affects reliability directly. It is planned and it should be performed at will. preventive maintenance is measured by the time it takes to perform specific maintenance tasks and the specified frequency maintenance effects availability directly.

2) **Corrective Maintenance:** Is the maintenance carried out after fault recognition and intended to restore an item to a state in which it can perform a required function. This includes all actions to return a system from a failed to an operating or available state. This is depended on reliability. Such a maintenance action can not be planned. It happens when one does not want it to occur.

3) **Controlled Maintenance**: A method to sustain a desired quality of service by the systematic application of analysis techniques using centralized supervising facilities and or sampling to minimize the preventive maintenance and to reduce preventive maintenance

2.4.1 MAINTENANCE POLICY

The maintenance policy adopted for a particular system will depend upon several factors. These are:

(1) Type of system

(2) Location

(3) Operating condition

(4) The required levels of reliability and availability

(5) The standard of skilled maintenance staff

(6) Provision of spare part

(7) Environment condition

2.4.2 MAINTENANCE STRATEGIES

A Maintenance strategy is really a statement of management policy related to form and type of maintenance practice, which should be pursued, by the company or organisation.

Most organizations identify two basic areas of maintenance responsibilities higher management usually has responsibility for major maintenance and repair decision involving repair or replacement of complete items of plant. Maintenance management has responsibility for routine maintenance, repair or replacement of both major and minor. Components parts of items of plant. This division of responsibility is considered essential because eternal factors, such as obsolescence sales cost of capital (long-term factors) and internal factors such as maintenance and operating lost (short terms factors) greatly influence the corporate decision on replacement of major item of plant.

The maintenance of other items of plants and associated components require the implementation of an appropriate maintenance policy or plan i.e. a maintenance strategy. There are a number of maintenance strategies or policies which can be specified either separately of each item of plant.

1) Fixed time maintenance
2) Operate to failure
3) Condition base maintenance
4) Design out maintenance
5) Opportunity maintenance
6) Planned preventive maintenance

Before considering the individual maintenance strategies in greater details it should noted that those actions that are carried out before failure can be regarded as preventive and those carried out after as corrective. Preventive maintenance actions are determined in advance and thus can be scheduled and carried out.

CHAPTER THREE

3.1 RELIABILITY ANALYSIS OF 11KV POWER SYSTEM WITH MINNA

Reliability assessment of a distribution system is usually concerned with the system performance at the customer end, then the basic indices to be considered are: Load point-failure rate, average outage duration and annual unavailability load point failure can be caused by cable failure transformer failure which is most time cleared by fuse, due to short circuit.

The analytical techniques to perform failure mode and effect. Might result into tables in which the following basic step are require from an equation. Suppose a line observed for an interval of time in which N cycle of failure (permanent fault) and repair are noted, then several time to failure cycle can be representing by M_i similarly corresponding time to repair to be represented by r_i for the cycle. Then

$M_i = 1/N \sum_{1}^{N} m_i$ and $r = 1/N \sum_{1}^{N} r_i$

The sum of average time to failure and average time to repair becomes.

$T = M + r$

Availability can be given as a ratio of Average uptime m to average cycle time T as follows:

$A = \dot{M}/\bar{r} = \bar{M}\ m - \bar{r}$

The reciprocal of mean time to failure is often designed as failure rate "2" meanwhile failure rate of a series of reliability system is the sum of device failure therefore.

$\lambda s = \lambda_1 + \lambda_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + \lambda_i$

$\lambda_s = \Sigma\ \lambda_i$ F/y, i.e failure per year

$r_s = \Sigma\ \lambda i r i / \Sigma \lambda_i$ h_r/f i.e. hour per failure

Where rs = time to repair each fault

And availability can be given as

$U_s = r_s \lambda_s$ hr/yr i.e. hour per year

It should be known to us that feeder that supply electricity to all customer are made therefore, failure rate per year can be calculate using this formula.

λ_{fdr} = failure rate of feeder

$\lambda_{fdr} = \Sigma\ \lambda_i = \lambda_{OH} + \lambda_{UG} + 2\lambda_{CT}$

where:

λ_{OH} = failure rate of overhead cables per year

λ_{UG} = failure rate of under Ground cable per year

λ_{CT} = failure rate of cable termination per year

From these basic distribution reliability indices, common indices that can be derived are discussed below only that they involves the number of customer or consumers.

(1) System Average interruption frequency index (SAIFI) this index is defined as the average number of interruption per customer served per the unit. It is estimated by diving the accumulated of consumer served.

$$SAIFI = \frac{\text{No of customer -interruptions}}{\text{Total no. of customer served}} = X/\text{customer year}$$

2) Customer Average Interruption Frequency index (CAIFI). is defined as the average number of interruption experience per customer affected per time unit. It is estimated by dividing the number of customer interruption observed in a year by number of customer affected.

$$CAIFI = \frac{\text{Total Customer interruption}}{\text{Customer affected}} = \text{int/yr/cw/yr}$$

3) System Average interruption Duration Index (SAID), this can be defined as the average interruption duration for customers served during a year. It is determined by diving the sum of all customers sustained in interruption durations during the year by the number of customers served during a year.

$$SAIDI = \frac{\text{Cumulative customer} - \text{minute interruption}}{\text{Total no. of customer served}} = \text{hr/by.lost}$$

4) Customer Average Interruption Duration Index (CAIDI), this index is defined as the interruption duration for customer interrupted during a year. It is determined by dividing the sum of all customer sustained interruption duration during the specific period by the number of sustained customer interruption during the year.

$$CAIDI = \frac{\text{Cumulative customer} - \text{hr interruption}}{\text{Total no. of customer interrupted}} = \text{hr/customers}$$

5) Average service Availability Index (ASAI), this is the ratio of the total number of customer hours that service was available during a year to the total customer hours demanded. The complementary value to the index i.e. average service unavailability index (ASUI).

Also, to calculated reliability and maintainability of Minna metropolis explanation are needed to know how electricity is distributed from the shiroro dam, how many feeders are used and where they served. also approximate number of transformer used in whole Minna metropolis.

3.2 THE 11KV POWER SYSTEM OF MINNA METROPOLOS

The two 132KV lines comes from Shiroro power station. At the shiroro substation near Shiroro hotel in Minna, two 30MVA step-down transformers are used to step-down 132KV to 33KV. Another two 15MVA step-down transformers are also used to step-down 33KV 11KV. At this stage, there is bus where the five feeders take their power to supply Minna metropolis.

The names of the five feeders are:

1) The parliamentary feeder
2) The chanchaga feeder
3) The Shiroro feeder
4) The Bosso feeder
5) The Piggery feeder

These feeders through the Ring main unit (RMU) feed into various 11KV/45Vstep-down transformers at the various substation in the town.

- The parliamentary feeder supplies Kpakungu, Government house, Shaira court and old state secretariat.
- The chanchaga feeder supplied custom house, house of Assembly, Niger State secretariat complex and chanchaga guates.
- The Shiroro feeder feeds place like Shiroro Hotel, bayclinic and Maitumbi area.
- The Bosso feeders feeds FUT Minna, Bosso Area and Maikunkele area.
- The piggery feeder: Feed place like catering Jafaru Guest inn stadium Mobil area

The six buses that comprise the 11KV power system for Minna, Metropolis are:

(i) Shiroro substation bus

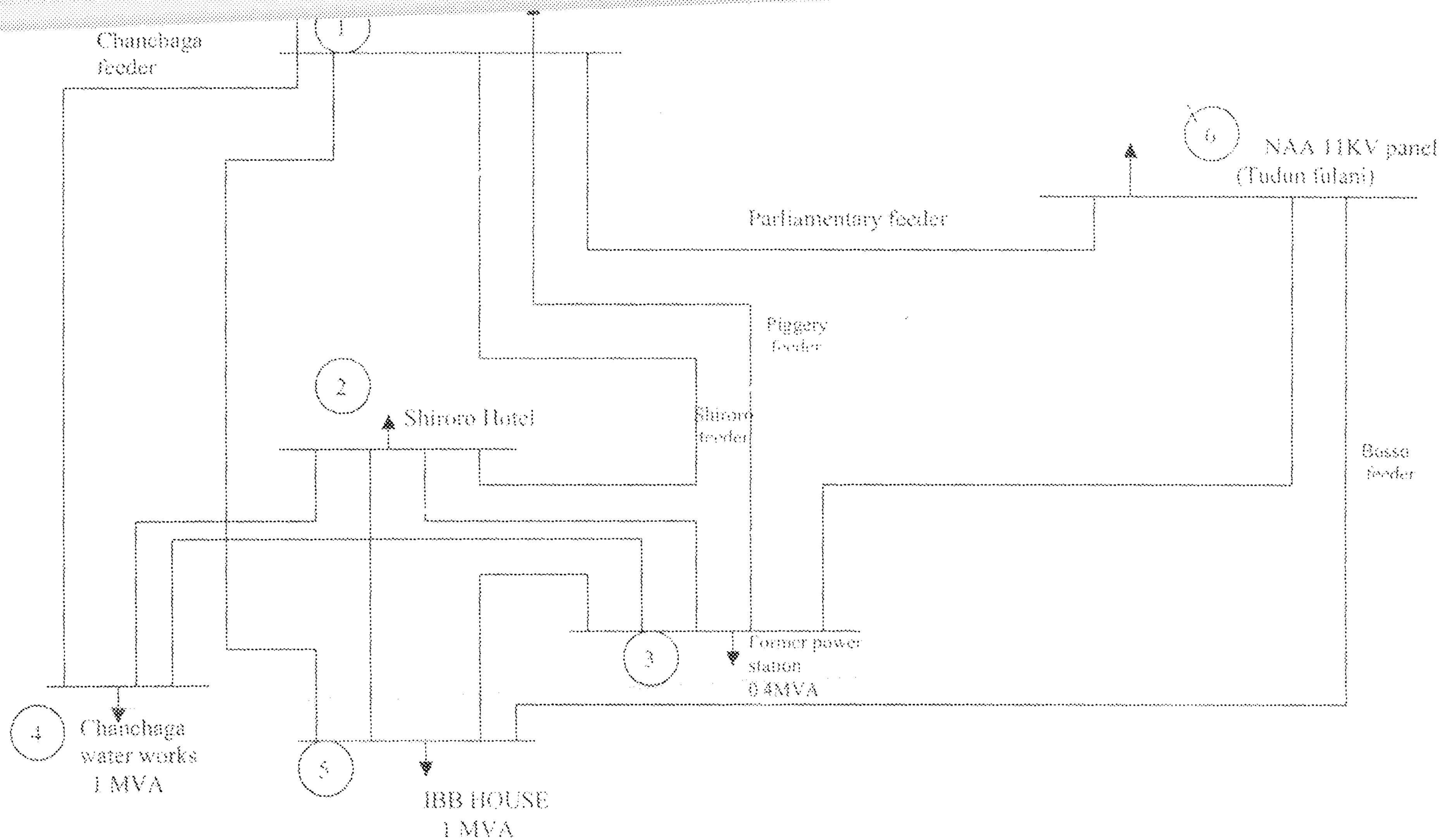
(ii) Former power station (near police Barrack) bus

(iii) IBB House bus

(iv) Chanchaga water works bus

(v) NAA 11KV panel bus (at Tudun falani)

For the purpose of this project work, we are especially concerned with the five feeders.



THE INTERCONNECTION OF THE BUSES WITHIN MINNA
METROPOLIS

DATA COLLECTION TABLE

Feeder	Total numbers of transformer	Distance covered (KM)	Failure rate of feeder (fault/year)	Failure rate of transformer 1/yr	P.of alternative supply	Replacement of transformer (hrs)	Repair time (hrs)	Probability of fuse to clear the fault
Parliamentary Feeder	78	30.4	0.906	0.008	0.2	12	6	0.3
Chanchaga Feeder	53	37	0.801	0.018	0.2	14	5	0.3
Shiroro feeder	30	20	0.703	0.001	0.2	18	5	0.3
Bosso feeder	70	19	0.901	0.007	0.2	17	6	0.3
Piggery feeder	20	22	0.604	0.004	0.2	18	5	0.3

The above data was collected from NEPA fault section (Minna District Office)

3.3 CALCULATION

PARLIAMENTARY FEEDER (1)

This feeder cover about 30.4km and has bout 78 distribution transformers.

The input parameter for this feeder are:

failure rate of feeder = 0.906 fault/year

repair time = 6hrs

failure rate of transformer = 0.008/year

probability of alternative supply = 0.2

probility of fuse to clear the fault = 0.3

replacement of transformer = 12 hrs

$\lambda i = \lambda s = \lambda_{fdr} + [\lambda_T \times N_T \times P(\text{fuse})]$ inf/yr

Where

λs = sum of failure rate/year in series

λ_{fdr} = feeder failure rate/year

λ_T = number of transformer in feeder

p(fuse) = probability of fuse to clear the fault

therefore

$\lambda_{s1} = 0.906 + [0.008 \times 78 \times 0.3]$

$= 0.906 + 0.1872$

$= 1.0932$ f/yr

And $r_s = \dfrac{\lambda i r i}{\lambda i}$ = hr/f

Where ri = time to repair each fault in hr

rs = total sum of annual output duration of the system in hr fault.

Therefore

$r_{si} = \dfrac{0.906 + 0.1872 \times 12}{1.0932}$

$r_{si} = \dfrac{0.906 + 2.2464}{1.0932}$

$r_{si} = \dfrac{3.1524}{1.0932}$

r_{sl} = 2.8836 hrs/fault

and

$Us = \lambda s \times r_s$ where Us is annual unavailability in hrs/yr

Therefore $U_{sl} = \lambda_{sl} \times U_{sl}$

$U_{sl} = 1.0932 \times 2.8836$

U_{sl} = 3.1524 hrs/yr

For p(alternative supply path) = p(0.2)

$U_{slp} = U_{sl} \times 0.2$

$U_{slp} = 3.1524 \times 0.2$

= 0.63048

Unavailability = 3.1524 hrs/yr. And we have 8760 hrs in a year.

Then availability = 8760 – 3.1524

= 8756.85

Reliability of parliamentary feeder = $\frac{\text{Availability}}{\text{Total sum of hour demand}}$

$= \frac{8756.85}{8760} = 0.99964$

CHANCHAGA FEEDER (2)

This feeder cover about 37km and has about fifty three (53) distribution transformers. It has the following input parameters:

Failure rate of feeder = 0.801 fault year

Repair time = 5hours

Failure rate of transformer = 0.018/year

Probability of alternative supply = 0.2

Probability of fuse to clear the fault = 0.3

Replacement time of transformer = 14hrs

$\lambda i = \lambda s = \lambda fdr + [\lambda_T \times N_T \times p(fuse)]$ in f yr

Where

λs = sum of fault rate/year in series

λfdr = failure rate of feeder/year

λ_T = failure rate of transformer

N_T = number of transformer in feeder

P(fuse) = probability of fuse to clear the fault

Therefore

$\lambda s2 = 0.801 - [0.018 \times 53 \times 0.3]$

$\lambda_{s2} = 0.801 - 0.2862$

$\lambda s2 = 1.0872$ f/yr

and $rs = \dfrac{\lambda i\, ri}{\lambda i}$ = hr/f

Where ri = time to repair each fault in hr

rs = total sum of annual outage duration of the system in hr/fault

$$rs2 = \frac{0.801 + 0.2862 \times 14}{1.0872}$$

$$rs_2 = \frac{0.801 + 4.0068}{1.0872}$$

$$rs_2 = \frac{4.8078}{1.0872}$$

$rs_2 = 4.422$

And $Us = \lambda s \times rs$, where Us is annual unavailability in hrs/yr

$Us_2 = \lambda s_2 \times rs_2$.

$Us_2 = 1.0872 \times 4.422$

$Us_2 = 4.8076$ hrs/yrs

For P(alternative supply path) = P(0.2)

$Us_{2P} = Us_2 \times 0.2$

$Us_{2p} = 4.8076 \times 0.2$

$Us_{2p} = 0.96152$

Unavailability = 4.8076 hr/yr and we have 8760 hrs in a year.

Therefore availability = 8760 – 4.8076

= 8755.19

Then reliability of Chanchaga feeder = $\frac{\text{Availability}}{\text{Total sum of hr demand}}$

$$= \frac{8755.19}{8760} = 0.99945$$

SHIRORO FEEDER (3)

This feeder cover about 20km and has thirty (30) distribution transformers.

The input parameters of this feeder are:

Failure rate of feeder = 0.703

Repair time = 5hrs

Failure rate of transformer = 0.001

Probability of alternative supply = 0.2

Probability of fuse to clear the fault = 0.3

Replacement of transformer = 18hrs

$$xi = \lambda s = \lambda_{fdr} + [\lambda_T \times N_T \times p(fuse)] \text{ in f/yr}$$

Where:

λs = sum of failure rate /year in series

λ_{fdr} = failure rate of feeder/year

λ_T = transformer failure rate

N_T = number to transformers in feeder

P(fuse) = probability of fuse to clear the fault

Therefore,

$\lambda s3 = 0.703 + [\,0.001 \times 30 \times 0.3]$

$\lambda_{s3} = 0.703 + 0.009$

$\lambda s_3 = 0.712$ f/yr

and $rs = \frac{\lambda i \, ri}{\lambda i} = hr/f$

Where ri = time to repair each fault in hr

rs = total sum of annual outage duration of the system in hr/fault

$rs_3 = \frac{0.703 + [0.009 \times 18]}{0.712}$

$rs_3 = \frac{0.703 + 0.162}{0.712}$

$rs_3 = \frac{0.865}{0.712}$

rs= 1.2149 hr/fault

And Us = λs x rs, where Us is the annual unavailability in hr/yr

$Us_3 = \lambda s3 \times rs3$

$Us_3 = 0.713 \times 1.2149$

$Us_3 = 0.8662$ hr/yr

For P(alternative supply path) = P(0.2)

$Us_3 = Us_3 \times 0.2$

$Us_{3p} = 0.8662 \times 0.2$

$Us_{3p} = 0.1732$

Since Unavailability = 0.8662 hr/yr and we have 8760 hrs in a year.

Therefore availability = 8760 – 0.8662

$= 8759.13$

Therefore Reliability of Shiroro feeder = $\frac{\text{Availability}}{\text{Total sum of hr demand}}$

$= \frac{8759.13}{8760} = 0.99990$

BOSSO FEEDER (4)

This feeder cover about 19km and as about seventy (70) distribution transformers it ahs the following parameters.

Failure rate of feeder = 0.901

Repair time = 6yrs

Failure rate of transformer = 0.007

Probability of alternative supply = 0.2

Probability of fuse to clear the fault = 0.3

Replacement of transformer = 17hrs

$$xi = \lambda s = \lambda_{fdr} + [\lambda_T \times N_T \times p(fuse)] \text{ in f/yr}$$

Where:

λs = sum of failure rate /year in series

λ_{fdr} = failure rate of feeder/year

λ_T = transformer failure rate

N_T = number fo transformers in feeder

P(fuse) = probability of fuse to clear the fault

Therefore,

$\lambda s_4 = 0.901 + [\,0.007 \times 70 \times 0.3]$

$\lambda_4 = 0.901 + 0.147$

$\lambda s_4 = 1.048$ f/yr

and $rs = \dfrac{\lambda i\, ri}{\lambda i}$ = hr f

Where ri = time to repair each fault in hr

rs = total sum of annual outage duration of the system in hr/fault

$rs_4 = \dfrac{0.901 + [0.147 \times 17]}{1.048}$

$rs_4 = \dfrac{0.901 + 2.499}{1.048}$

$rs_4 = \dfrac{3.4}{1.048}$

$rs_4 = 3.244$ hr/fault

And $Us = \lambda s \times rs$, where Us is the annual unavailability in hr/yr

$Us_4 = \lambda s_4 \times r_{s4}$

$Us_4 = 1.048 \times 3.244$

$Us_4 = 3.3997$ hrs/yr

For P(alternative supply path) = P(0.2)

$Us_4 = Us_4 \times 0.2$

$Us_{4p} = 3.3997 \times 0.2$

$Us_{5p} = 0.67994$

Since Unavailability = 3.3997 hr/yr and we have 8760 hrs in a year.

Therefore availability = 8760 – 3.3997

= 8756.60

Therefore reliability of Bosso feeder = $\frac{\text{Availability}}{\text{Total sum of hr demand}}$

$= \frac{8756.60}{8760} = 0.99961$

PIGGERY FEEDER (5)

This feeder cover about 22km and has about twenty (20) distribution transformers. It has the following input parameters

Failure rate of feeder = 0.604

Repair time = 5hrs

Failure rate of transformer = 0.004

Probability of alternative supply = 0.2

Probability of fuse to clear the fault = 0.3

Replacement of transformer = 18hrs

$$\lambda i = \lambda s = \lambda_{fdr} + [\lambda_T \times N_T \times p(fuse)] \text{ in f/yr}$$

Where:

λs = sum of failure rate /year in series

λfdr = failure rate of feeder/year

λ_t = transformer failure rate

N_T = number of transformers in feeder

P(fuse) = probability of fuse to clear the fault

Therefore.

$\Lambda s_5 = 0.604 + [0.004 \times 20 \times 0.3]$

$\lambda_{s5} = 0.604 + 0.024$

$\lambda s_5 = 0.628$ f/yr

and $rs = \frac{\lambda i\ ri}{\lambda i}$ = hr/f

Where ri = time to repair each fault in hr

rs = total sum of annual outage duration of the system in hr/fault

$rs_5 = \frac{0.604 + [0.024 \times 18]}{0.628}$

$rs_5 = \frac{0.604 + 0.432}{0.628}$

$rs_5 = \frac{1.036}{0.628}$

$rs_5 = 1.6497$ hr/fault

And Us = λs x rs, where Us is the annual unavailability in hr/yr

$Us_5 = \lambda s_5 \times rs_5$

$Us_5 = 0.628 \times 1.6497$

$Us_5 = 1.0360$ hr/yr

For P(alternative supply path) = P(0.2)

$Us_{5p} = U_{s5} \times 0.2$

$Us_{5p} = 1.0360 \times 0.2$

$Us_{5p} = 0.2072$

Since Unavailability = 1.0360 hr/yr and we have 8760 hrs in a year.

Therefore availability = 8760 – 1.0360

= 8758.964

Therefore reliability of Piggery feeder = $\frac{\text{Availability}}{\text{Total sum of hr demand}}$

$$= \frac{8758.964}{8760} = 0.99988$$

3.4 MAINTAINABILITY ANALYSIS OF 11KV POWER SYSTEM WITHIN MINNA METROPOLIS

Maintainability is measured by the probability that the maintenance of a system (E) performs under given condition using a stated procedure and resources. It is denoted as

$M(t) = p[E \text{ was repeated over } (O,t)]$

The reverse is non-maintainability

$M'(t) = 1 - M(t)$

Maintenance, generally means the ability of a system to be restore to a state in which it can perform a required function. maintenance comes in three forms predictive, corrective and preventive. Flexibility and cost are most factors to consider.

But the entire concept can be approached on to a repairable system i.e. ability of system to reserve the performance of its function after a failure.

Whenever a system fails to perform to the required capacity, it is said to be fault. It is an interruption in normal functioning or operation of a system. The implication of fault in NEPA network is that it affects the power supply. In 11Kv distribution network within Minna metropolis. Installed equipment could be faulty due to the following reasons; short circuit, overload, damage feeder pillar unit, slacking of conductor line etc.

Fault usually detected by NEPA during line patrol of line tracing or simple by the complain. Correction of faulty is either take four (4), six (6). hours but the NEPA staff sometimes spend two to three hours to correct the fault.

Some of the correction made to clear the fault are change of feeder pillar unit damage, retensioning with jack-pull change of damage cross arm, separation of aluminum conductor with line spacer, replacement of J and P fuse that drops.

3.5 CALCULATION

PARLIAMENTARY FEEDER (1)

This feeder has repair time of 6 hours and average time taken to repair it, by NEPA staff is 2 hours. Therefore it has the following parameters.

Repair time (t) = 6 hours

Average time taken to repair = 2 hours

And maintainability = $m(t) = 1 - e^{t/MTTR}$

Where t = repair time

MTTR = average tie taken to repair

Therefore.

$M(t) = 1 - e^{-6/2} = 1 - e^{-3}$

$M(t) = 1 - 0.049787$

$M(t) = 0.950213$

Therefore, the probability of this feeder (parliamentary feeder) being returned to work after faulty, within 2 hours is 0.95312 or 95.0214

CHANCHAGA FEEDER (2)

This feeder has repair time of 5 hours and average time taken to repair it, by NEPA staff is 1.5 hour. Therefore it has the following parameters.

Repair time (t) = 5 hours

Average time taken to repair = 1.5 hours

And maintainability = m(t) = 1 – e $^{-t/MTTR}$

Where t = repair time

MTTR = average tie taken to repair

Therefore,

And maintainability = m(t) = 1 – e $^{-t/MTTR}$

$M(t) = 1 - e^{-5/1.5}$

$M(t) = 1 - 0.035673$

$M(t) = 0.964327$

Therefore, the probability of this feeder (Chanchaga feeder) being returned to work after faulty, within 1.5 hour is 0.964327 or 96.4327%

SHIRORO FEEDER (3)

This feeder has repair time of 5 hours and average time taken to repair it, by NEPA staff is 1.5 hour. Therefore it has the following parameters.

Repair time t = 5 hours

Average time taken to repair = 1.5 hours

And maintainability = m(t) = 1 – e $^{-t/MTTR}$

Where t = repair time

MTTR = average tie taken to repair

Therefore,

And maintainability = $m(t) = 1 - e^{-t/MTTR}$

$M(t) = 1 - e^{-t/1.5}$

$M(t) = 1 - 0.035673$

$M(t) = 0.964327$

Therefore, the probability of this feeder (Shiroro feeder) being returned to work after faulty, within 1.5 hour is 0.964327 or 96.4327%

BOSSO FEEDER (4)

This feeder has repair time of 6 hours and average time taken to repair it, by NEPA staff is 2 hours. Therefore it has the following parameters.

Repair time (t) = 6 hours

Average time taken to repair (MTTR) = 2 hours

And maintainability = $m(t) = 1 - e^{-t/MTTR}$

Where t = repair time

MTTR = average tie taken to repair

Therefore,

$M(t) = 1 - e^{-6/2}$

$M(t) = 1 - 0.049787$

$M(t) = 0.950213$

Therefore, the probability of this feeder (Bosso feeder) being returned to work after faulty, within 2 hours is 0.950213 OR 95.0213%.

PIGGERY FEEDER (5)

This feeder has repair time of 5 hours and average time taken to repair it, by NEPA staff is 1.5 hour. Therefore it has the following parameters.

Repair time (t) = 5 hours

Average time taken to repair = 1.5 hours

And maintainability = $m(t) = 1 - e^{-t/MTTR}$

Where t = repair time

MTTR = average tie taken to repair

Therefore,

And maintainability = $m(t) = 1 - e^{-t/MTTR}$

$M(t) = 1 - e^{-5/1.5}$

$M(t) = 1 - 0.035673$

$M(t) = 0.964327$

Therefore, the probability of this feeder (PIGGERY feeder) being returned to work after faulty, within 1.5 hour is 0.964327 or 96.4327%.

CHAPTER FOUR

4.1 DISCUSSION OF RESULTS

The table below (Table 4.1) show the results from the previous chapter, in which feeder indices, such as fault rate, annual outage duration, annually unavailability etc as well as their restoration time are mostly input parameters considered.

Feeders indces	Parliamentary feeder	Chanchaga feeder	Shiroro feeder	Bosso feeder	Piggery feeder
λ(f/yr)	1.0932	1.0872	0.712	1.048	0.628
R (hr/f)	2.8836	4.4222	1.2149	3.244	1.6497
U (hr/yr)	3.1524	4.8076	0.8662	3.3997	1.0360
U_A (hr/yr)	0.6304	0.96152	0.1732	0.67994	0.2072
ReL	0.99964	0.99945	0.99990	0.99961	0.99988
M(t)	0.950213	0.964327	0.964327	0.950213	0.964327

It can be deduced from table that the failure rate is high in Chanchaga and parliamentary feeder, it may be due to overloading of transformers cause mainly by dense population.

2Meanwhile, reliability is high at piggery, Bosso and shiroro feeder. this may be due to higher maintenance rate provided by NEPA staff to this feeder, since power outage in this feeders, will be accompanied by danger to the people, enormous damage to the economy and also disturbance to the normal living condition of people.

However, the overall reliability and maintainability, is calculated as follows respectively.

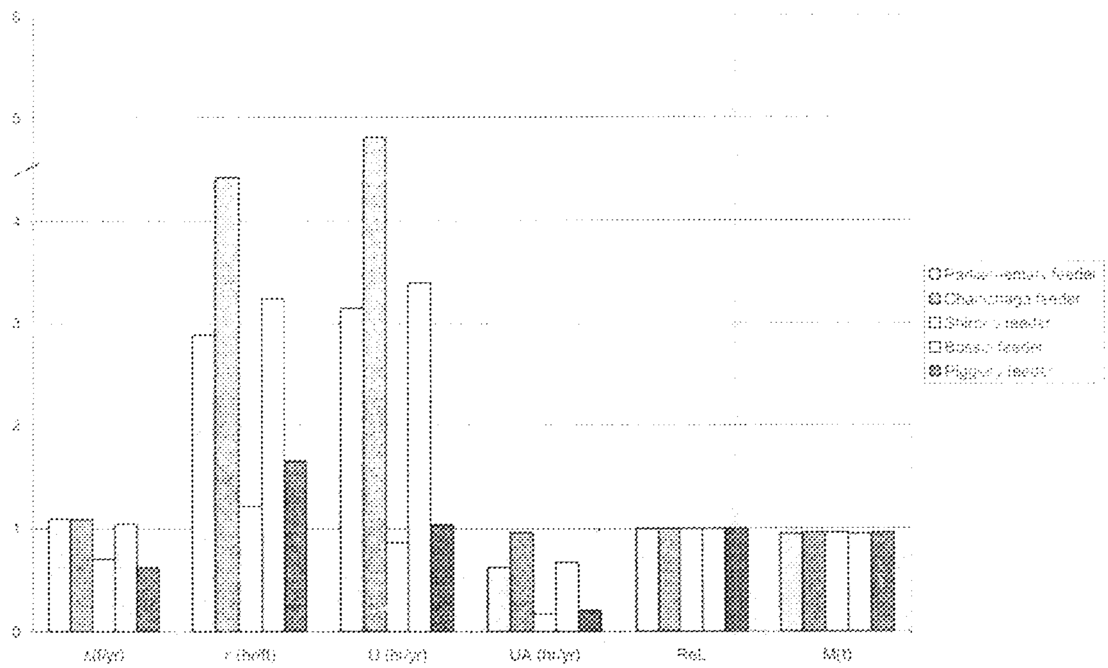
$$RT\ overall = \prod_{i=1}^{5} = Ri = R1R2 \text{------------------} R5$$

$$RT\ overall = \prod_{i=1}^{5} = M(t)i = M_1(t) \times M_2(t) \text{------------} M_5(t)$$

Therefore overall reliability = 0.99848

and overall maintainability = 0.80968

GRAPH SHOWING RESULT OBTAINED OF EACH FEEDER



4.2 PROGRAM

In the process to analysis the basic reliability and maintainability of the feeder, it was realized that it is very tedious and bound to error if proper care is not taken, therefore to prevent these, a computer software program is design using a well known Basic High-Level language to calculate reliability and maintainability of a feeder which involves failure rate of transformer and feeder perineum, annual availability and repair time e.t.c. The program goes does.

```
10   PROGRAM TO DETERMINE DISTRIBUTION RELIABILITY
     AND MAINTAINABILITY

20.  INPUT "FEEDER FAILURE RATE", F

30   INPUT "DISTANCE COVERED BY FEEDER", D

40   INPUT "FAILURE RATE OF TRANSFORMER", FX

50   INPUT "NUMBER OF TRANSFORMER", RX

60   INPUT "NUMBER OF TRANSFORMER UNDER A FEEDER", NX

70   INPUT "PROB OF FUSE TO CLEAR FAULT", PF

80   INPUT "PROB ALTER SUPPLY", PA

90   INPUT "REPAIR TIME OF FEEDER",RT

100  INPUT "AVE TIME TAKEN TO REPAIR FEEDER", AV

110  LET λX = FX* N* PF

120  LET λS  = f + λX

130  LET RS = (F + λX  * RX)/λX

140. LET US = RS * Λs

150. LET USA = US * PA

160  LET REL = (8760 – US)/8760

170  LET MAIT = 1 – e (-RT/AV)

180  PRINT "RELIABILITY OF FEEDER", REL

190  PRINT "MAINTAINABILITY OF FEEDER", MAIT

200  END
```

4.3 CONCLUSION

Methods used to quantify reliability and maintainability of a power system are the mathematics of probability and statistics. It is because in reliability and maintainability one is dealing with some uncertainly. Probabilistic as opposed to the deterministic approach has become more wide spread.

As electric power system is a complex interconnected network of components; overall system reliability is dependent upon the design, reliability of the individual component and system in conjunction with availability or replacement of faulted component. The relationship between cost and reliability is also a complex relationship of equipment and instability in cost , lost revenue lost energy production and other factors

The analytical technique presented or utilized in this project is in fact, decomposition algorithm for system reliability estimation of electric power system with aim of solving complexity in analysis of system with aim of solving complexity in analysis of system reliability .This project is designed and develop a software program to analysis of critically using some distribution reliability indices e.g failure rate ,replacement of transformer e.t.c the available protection system network configuration with statistical data on the like hood fault occurrence to estimate the overall reliability and maintainability of electric power system to any consumer from the sub station used as case study.

This gives a result of expecred hour for any feeder to resume to work after fault occurrence and will be useful to engineers in designing network or improving the existing ones

4.4 RECOMMENDATION

The National Electric Power Authority (NEPA) Minna branch should ensure that there is an up to date drawing of the distribution network of the town.

Before deciding whether to improve the reliability of a system by fault tolerance or avoidance a reliability assessment of each component in the system should be made once reliability value of component can be performed in order to determine in order to determine if that system reliability can not be achieved at the specified time.

A standard reporting procedure and record keeping which gives enough information should be adopted. This may find further use in planning, maintenance and operation.

Preventive maintenance should be made to ensure that trees and branches that are close to overheat lines are properly trimmed. This prevent the tripping of circuit breakers will be minimized to increasing the reliability of network.

Also, to increase higher reliability, scheduled maintenance should be adhere to in which the equipment, line and other associated component, such as cross arms, insulators e.t.c.

For uninterrupted supply feeders may be constructed in pairs so that when one feeder fails, the other can easily be switched to at various substation.

REFERENCES

1. ANTHONY J. PANSINI., "Electrical Distribution Engineering", McGraw-Hill book company, New York, 1986.

2. B.M WEEDY., "Electrical power System", 3rd Edition., John Wiley and Sons; Toronto 1992.

3. ROBERT J. AND RINGLEE; "Power system Reliability"; 2nd Edition, Wiley, New York, 1957.

4. DAVID I GERTMAN AND HAROLD S. BLACKMAN; "Human reliability and supply data hand book, Methuen, London, 1950.

5. J.O OFULULE; "Reliability of Electrical and Electronics Component", Macmillan education Ltd 1995.

6. www.emerson/news

7. www.hcgm.edu.rel

8. VANZIG, Seismic Reliability of electrical power network methodology and application structural safety; Methuen London 1996.

9. NEPA: Minna District Daily fault Log Book.

10. Mr Asulu; Reliability and maintainability of electrical component and system; lecture Note; 2003/2004 session.