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On the Centralization of Reliability in Maintenance Practices in the Nigeria Power System Network: A Review

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***Abstract*—**An effective maintenance practice is one which involves a strategic framework aimed at improving the overall performance of a system by reducing the number of failures in the system. The main attribute of sound maintenance management will be to effectively plan the system to operate with a status-quo so as to avoid all kinds of failure within the system. This paper presents a review of the present maintenance practices in the Nigeria Power System Network NPSN. It was observed from the review that the maintenance strategy presently adopted by the NPSN has not been effective due to the increase in the number of failures arising from poor maintenance. This paper proposes the incorporation of Reliability-Centered Maintenance RCM as an effective maintenance strategy in the NPSN when adopted, RCM strategy will give priority to the operating context of the equipment within the NPSN; give maintenance personnel opportunity to react to potential failures, reduce unnecessary maintenance within the system and provide maintenance personnel opportunity to carrying out round the clock maintenance system. The RCM has overall aim of improving the reliability of the NPSN and this will reduce the down time of the power system and guarantee return on investment in a deregulated power industry.

***Keywords*—** The RCM, NPSN, Maintenance, Reliability, Power.

I. INTRODUCTION

The determinant of the effectiveness and sustainable efficiency and growth for any electrical power systems operated by either a public utility, a monopoly wholesaler or supplier, an independent private supplier, or a distribution company, is its ability to operate safely and to be available whenever needed i.e. adequacy of facilities to be essentially supported by appropriate planning, operational protection and control methods, adequate maintenance etc.

Increase in industrial development in a country leads to a corresponding increase in the demand for electric power, it, therefore, becomes necessary to tap all the available energy sources in the country for the development of electric power and utilize the most economical to produce maximum power [1].The reliability of power system network is its ability to serve the total power demand by customers without failure over a long period of time. The Nigerian power system network is presently characterized by aging equipment, poor maintenance culture to mention but a few [2] leading to a poor reliability of the system.

Electricity supply in any country is a function of several factors, such as the level of deposit of primary source of energy in such country, the level of electricity generating technology coupled with the available and effective capacities, the institutional framework for electricity generation, and the operational efficiency of the institutional framework. Ironically, we keep hearing from the media efforts by the government to improve power generation but no corresponding information on how to maintain the system so as to derive the maximum utilization of the present installed capacity. Besides this, most associated equipment, machines and others facilities for generation had operated for several years beyond their normal life span without adequate and regular maintenance, servicing and rehabilitation [3] leading once more to a poor reliability in the system. According to [4] in order to improve on the maintenance strategy of Power Holdings Company of Nigeria PHCN, the researcher proposed a Utility Availability Centered Maintenance Strategy UACMS model that combined various maintenance techniques in addition to the work authorization hence, the entire strategy was eventually linked to a central computer database support block for information management purposes. Furthermore, [5] laid emphasis on how poor training of maintenance personnel has contributed in hindering maintenance action, the work further stresses that the then PHCN staffs are not regularly and effectively trained to meet up with the current maintenance trend practiced globally in an industrialized nation. Although, the work was primarily aimed at addressing poor training of maintenance personnel neglects maintenance of equipment and fails to recommend the best maintenance action for this purpose. Also, [6] emphasizes that poor maintenance culture has contributed to being one of the major factors responsible for the epileptic power supply in Nigeria. In addition, [7] developed a model with a five stage algorithm. From the model, 80% of its functionality was assigned to preventive maintenance while 20% was assigned to corrective maintenance. Although the high percentage of preventive maintenance could help reduce the severity and frequency of unplanned failures but it may just ignore the economic and technical analysis of the system.

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II. MAINTENANCE PRECEPTION IN NIGERIA POWER SYSTEM

According to Kurt Vonnegut, Jr. (1990), "Another flaw in the human character is that everybody wants to build and nobody wants to do maintenance." Presently in the Nigerian power sector, this statement is voidable as it is apparent that emphasis is placed on power generation while little efforts have been put into the maintenance of the system. Although, maintenance department exists in the Nigerian power sector to clear failures using the available maintenance strategy but it is ironical that these failures cannot be curtailed and as a result the rate of electric energy poverty due to poor maintenance approach is on the increase [4].This can be attributed to the absence of effective and efficient maintenance policy in place to guide operation and maintenance personnel and also the issue of diverse interest rather than national interest has stalled the workers from working together in achieving the organization's maintenance goals and effective operation. Three years (2004 -2007) data were used in the determination of the FGGC Feeder reliability in Benin City using fault tree analysis. The fault identification, probability of occurrence and interactions leading to higher order faults using logic gates for the fault tree diagram was carried out. Load shedding, equipment/component failures and maintenance activities were responsible for the feeder outage [8].

According to [9], the contributive effect of maintenance engineering will be to improve maintenance operations, reduce the amount and frequency of maintenance, reduce the effect of complexity, establish the extent of preventive maintenance to be carried out, improve and ensure maximum utilization of maintenance facilities, and improve the maintenance organization. But in the Nigerian power network emphasis are laid more on building new power stations than in maintaining existing ones hence, maintenance is often not given the priority it deserves in the overall operating strategy of the network. Human nature seems to abide by the believe that "If it isn't broke, don't fix it , this scenario according to [6], is currently been experienced in the Nigerian power sector which is characterized by unplanned maintenance carried out after system's failure. Compared to other departments, maintenance departments have no real "product" and as such produces no real income hence, managers of utilities view money spent on maintenance as a waste of resources and this is because the present maintenance approach adopted is not cost effective. A major effect of poor maintenance strategy is the loss of load, financial loss, technical loss etc. this is because presently, there is no lay down policy that guides the maintenance personnel with respect to how effective maintenance should be carried out [10], hence, maintenance personnel often wait for an equipment to break before it is fixed. One can, therefore assert from the foregoing that the maintenance actions proposed by the various researchers do not take into account the probabilistic interpretation of the system's operating context.

III. CONVENTIONAL MAINTENANCE PRACTICE IN NIGERIA

It is evident from [6][10], that the maintenance culture practiced in the Nigerian power system network could either be planned or unplanned. In either case the effectiveness of this maintenance strategy has already been questioned by [4] due to the increase in the number of failures that could have been taken care of if a well-organized maintenance program were to be in place. Figure 1 and Figure 2 shows the present maintenance practice in Nigeria.

Figure 1. Planned Maintenance

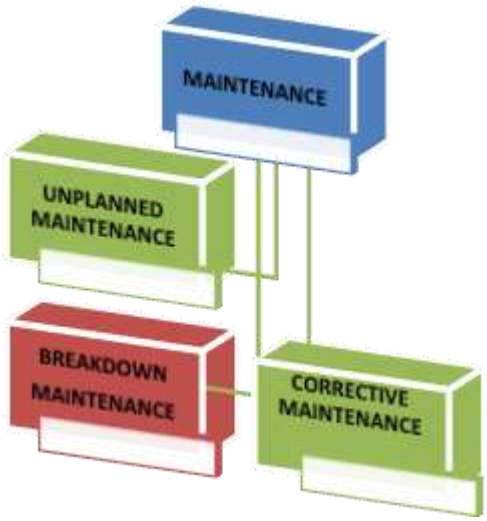

Figure 2. Unplanned Maintenance

A. Planned Maintenance

This type of maintenance approach includes preventive, predictive or corrective maintenance. Although planned maintenance can help reduce the frequency and severity of unplanned maintenance but it can lead to a significant increase in inspection, routine maintenance, increase in maintenance cost and can also introduce an infant mortality to an already stable system if practiced too much.

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B. Unplanned Maintenance

This can either be breakdown maintenance in which the system is fixed after a breakdown must have occurred or corrective maintenance which is meant to correct failures within the system. In terms of reliability, this strategy can be disastrous because of relatively high cost, unplanned downtime, damaged machinery, and overtime expenditure.

IV. Evolution of RCM

RCM was intended by [11] for the development of aircraft scheduled maintenance programs to be generally acceptable based on safety and operational risk control reasons for maintenance activities. Eventually, [12], asserts that RCM was first introduced by Nowlan and Heap and subsequently popularized by John Moubray. Subsequently, it was observed that RCM could also be applied to other engineering facilities for a possible improvement in the maintenance of such system and as a result of this, many researchers have ventured into the study of RCM giving it diverse definitions based varying applications. According to [11] RCM is a kind of scheduled maintenance program designed to realize the inherent reliability capabilities of the equipment. According to [13], power transmission utilities need to reduce the cost of maintenance, the repair cost, and the electrical supply cost while maintaining sustained system reliability. According to [9] RCM is a systematic process used to determine what has to be accomplished to ensure that any physical facility is able to continuously meet its designed functions in its current operating context. In addition, [14] defines RCM as a process used to determine what must be done to ensure that any physical asset continues to do what its users want it to do in its present operating context. Furthermore, [15] defines RCM as a process used to determine what must be done to ensure any physical asset continue to do whatever its users want it to do in its present operating context. RCM is an approach to maintenance that tries to create an optimum mixture of an intuitive approach and a rigorous statistical approach to deciding how to maintain facility equipment [12]. According to [16], RCM implies planning future maintenance actions based on the estimated reliability indices of the system at the moment of planning. According to [17], RCM is the optimum mix of various maintenance practices with a view to improving the reliability and availability of the system. Based on [18] RCM is a method used to identify and select failure management policies to efficiently and effectively achieve the required safety, availability and economy of operation, while [19] asserts that RCM is a process used to determine the maintenance requirements of any physical asset in its operating context. Furthermore,[20] agrees that RCM approach is chosen for utilities because of its advantages in reduced frequency of maintenance which could eventually reduce the cost of running the system and quick wear. From these existing literatures, one can, therefore, assert that RCM is a maintenance strategy that focuses more on the functionality of individual components that makes up a system with a view of improving the overall reliability of the system. It looks at what is needed to be done to ensure that the availability of the components that make up a system is close to unity at all times. Unlike the conventional maintenance practice which leads frequently to unnecessary equipment service outage and non-extension of component's life. RCM, when adopted will optimize maintenance procedures through reliability improvement and cost improvement by comparing the various maintenance policies in place and making use of the most cost-effective and efficient processes.

V. The Components of RCM

This is basically the structure that makes up the RCM. It allows the maintenance personnel the opportunity to make a judgment on a particular equipment with respect to the equipment' s present operating condition thereby creating room for the personnel to be more proactive and also to react to a given potential failure instantaneously thereby preventing failures in the equipment and in the entire system. Fig. 3 has shown the basic RCM component, it is evident that the inclusion of proactive and reactive measures as part of the maintenance strategy is to provide an opportunity to carry out maintenance as the system operates and not to wait for breakdown or for a routine maintenance action thereby improving the overall system reliability.

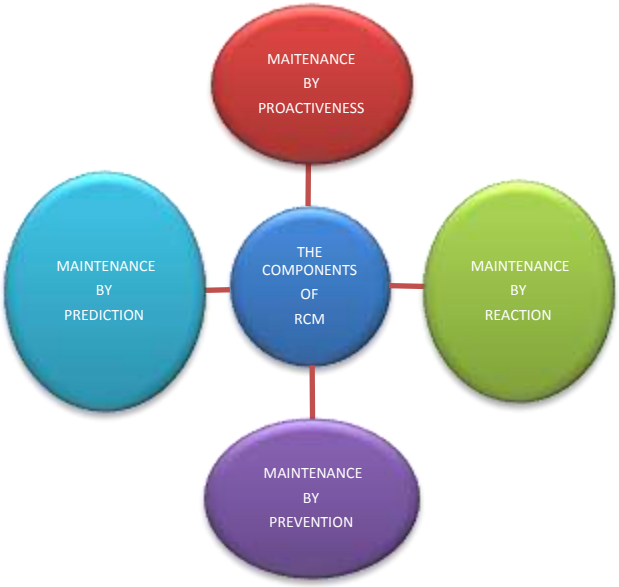

Figure 3. The Basic Components of RCM

From Fig 3, it can be seen that the components of RCM includes: Reactive, Proactive, Preventive and Predictive maintenance. Reactive maintenance provides the maintenance personnel opportunity to react to a given failure the moment the failure is observed by carrying out replacement or parts repair, the idea is to get the system or equipment back to service as quickly as possible while proactive maintenance is aimed at continual maintenance of the system irrespective of the time and the system's functionality through the use of feedbacks and ensuring better design. The predictive maintenance look for parts potential failure initiation so as to remove failure through the redesigning of the failed equipment, while preventive maintenance is poised at carrying out all processes that can prevent failure within the system. Example of such is in replacing all aged parts in the system. However, none of these RCM components is to be practiced in isolation

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from the others because these components have been designed and integrated to take advantage of their respective strengths in order to improve on system operation and reliability which will eventually lead to a corresponding reduction in the life-cycle cost of the system, efficient use of manpower through the use of a better user interface program by a RCM specialist. Hence, practicing RCM, should be based on the informed judgment from the RCM analysis. In general, RCM recognizes the fact that all equipment that makes up a system has different probabilities hence; the maintenance of the system should be based on the different probabilities of the various equipment that makes up the system by choosing the right maintenance technique for a particular system/equipment. Part of RCM strategy may even be to allow the system/component to run-to-failure if the consequence is minimal.

VI. BENEFITS OF RCM IN THE NPSN

RCM will provide the following merits when adopted

I. It determines the root cause of a failure before carrying out maintenance.
II. It does not look at the maintenance of the system as a whole but rather on the maintenance of the individual components/equipment that makes up a system
III. It helps in improving the reliability and availability of the system through the reduction of the probability of sudden equipment failure
IV. It considers the present operating context of a system before carrying out a maintenance action
V. By prioritizing equipment to be maintained in a system, it helps in reducing maintenance cost by eliminating unnecessary maintenance of equipment.
VI. It allows maintenance personnel to react almost instantaneously to failures within the system

VII. CONCLUSION

This paper has reviewed the various maintenance strategy presently applied in the Nigerian power system network. It was established from the review that the NPSN is presently poorly maintained leading to an epileptic power supply within the country. The work also established that only little work has been done in the area of RCM with respect to the NPSN thereby leading to a corresponding low awareness of the maintenance strategy. The paper hence identified this problem as a gap which needs to be filled.

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