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Maintenance: Step to Reliability of Electrical Power Supply System

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ABSTRACT

This paper looked at some major problems that negatively affect maintenance management in our electrical industry. Some remedial measures have been reviewed to improve the maintenance culture. Adequate maintenance adds to the life of any equipment and indeed any system. To ensure effective maintenance, effective management, financial discipline, adequate staff development and good staff welfare scheme, among others, should be put in place.

Keywords: *Maintenance, Power System, Reliability, Generation, Transmission, Distribution.*

1. INTRODUCTION

In Nigeria, electric energy generation and delivery have constituted a dominant parameter in most domestic activities and industrial development. Hence, the conscientious effort of the Federal Government of Nigeria to re-structure her power sector to attain greater efficiency, improve service delivery and increase private sector participation. Although these efforts had been on, power supply situation in the country presently has not been satisfactory and efficient. The reason is not far-fetched. Some existing machinery or equipment used in this sector is not regularly maintained while those whose parts are worn out are not replaced. Therefore, maintenance of this equipment will certainly improve its effective operation to give satisfactory service.

Furthermore, maintenance which is a function of reliability can extensively be discussed under these subdivisions of the electric power system [1]:

(i) Generation
(ii) Transmission
(iii) Distribution
(iv) Control and protection

Figure 1 shows the schematic diagram of an electrical power system showing the principal element of the subdivisions.

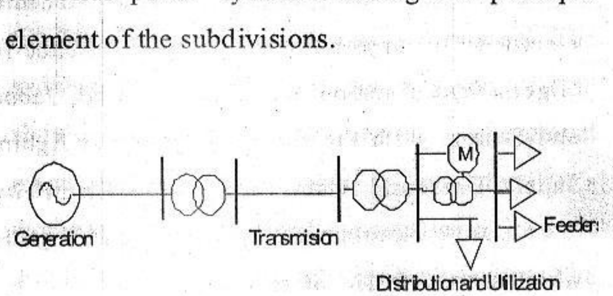

Figure 1: A Schematic Diagram of an Electrical Power System.

1.1 Generation

The major component of this subdivision is the generator, which is coupled to the prime mover. The generator is the core of an electrical power system and its nature and design depends on the source of primary energy i.e. steam, gas, water power or diesel [2]. A generating unit is a complex system comprising the generator stator winding and associated transformer and unit transformer, rotor with its field winding and exciters, and the turbine and its associated condenser and boiler complete with auxiliary fans and pumps. Faults of many kinds can occur within the system for which diverse protective means are needed. It is desirable to watch out for the following hazards.

(i) Stator insulation faults
(ii) Overvoltage
(iii) Unbalanced Load
(iv) Rotor fault
(v) Loss of excitation
(vi) Loss of synchronisation
(vii) Failure of prime mover
(viii) Excessive vibration etc.

1.2 Transmission

Modern practice demands sitting of generating stations as close as possible to the primary source of convertible energy and then to transmit electricity to the centres of utilization. Hence in Nigeria hydro station are sited at Kainji, Jebba and Shiroro with the thermal stations at Egbin, Sapele, Delta and Afam, respectively. Electricity is transmitted through a 330kV and 132kV grids which span virtually the entire country.

The overhead transmission lines are prone to lightning strikes, interference by falling trees, birds, vandals and cable thieves. The last two are the most devastating as their actions cannot be easily protected or detected by relays and other protective gadgets. As the area covered is quite extensive, monitoring by linesmen is cumbersome and very expensive due to the terrain.

1.3 Distribution System

Overhead distribution is practiced in most of the country and the greatest menace on the power system is experienced on this section of the system. The problems here range from illegal connections to inability by Power Holding Company of Nigeria (PHCN) to upgrade overloaded distribution transformers.

1.4 Control and Protection System

Control and protection systems are incorporated on the power system to increase the overall efficiency of the system. The cost of installing control and protection systems may be comparatively small but they ensure service continuity and at the instance of faults protect the system from destruction.

The primary objective of any electricity supply undertaking is to provide uninterrupted power supply to the consumers. This is only possible when the enumerated subdivisions are adequately maintained. The life of the elements of the subdivisions is prolonged when each element is given appropriate maintenance attention.

2.0 OVERVIEW OF MAINTENANCE

The maintenance of electrical power supply system is essential as all the vital sectors of human life depend on power. Over the years, there have been lots of public outcries in Nigeria about inadequacy of the nation's electrical power supply system. Effective maintenance can only result from a systematic approach in the formulation and documentation of maintenance programme. Different classifications exist but four types of maintenance systems are readily discernible as follows [3]:

(1) Breakdown Maintenance: This is a maintenance scheme whereby no maintenance action is taken until failure occurs. Breakdown maintenance is not in real sense a maintenance system. With this scheme no attempt are made at analysing the cause of failures. This approach may appear economical and may be so over short period, for all but the simplest of systems where output does not depend on the state of the plant except when total failure has occurred. This form of maintenance is a recipe for disaster. The scheme contains no ingredients of a systematic maintenance programme.

(2) Routine Maintenance: This is a maintenance system in which limited and simple services is undertaken in a regular manner as much as affordable. This approach easily establishes a pattern that can be repeated without further instructions. As simple as this system is, requiring limited paper work, it can be quite effective in intercepting developing faults.

(3) Planned Maintenance: This is a scheme that closely follows the programme as specified by the equipment manufacturer. This is normally constructed around the period or level of plant operation. With time however, the maintenance planner is able to acquire the requisite knowledge to modify the programme to include local conditions and experience and thereby achieve maximum economy.

(4) Preventive Maintenance: This system aims at doing everything possible to avoid a breakdown. This is the most elaborate system of maintenance and is employed for systems where failures are unacceptable. This will naturally apply to the operation of Power Holding Company of Nigeria (PHCN), an aircraft, etc. Preventive maintenance will normally restore the equipment to as-new state, and accordingly achieve a high level of plant reliability.

2.1 Basic Requirements for Effective Maintenance

Let us consider some of the factors that should necessarily be factored into the project to enhance and ensure maintainability.

(i) *Equipment Standardisation*: Equipment standardisation effectively limits the amount of spare parts that need be stocked at any given time. It reduces the variety of equipment that the maintenance work force has to cope with thereby the training needs and costs attendant to it. Establishment of comprehensive standard for any big organisation is a mean task and requires specialized expertise. Such personnel may not be required by the normal activities of the organisation and thus resort to consultants; this provides some advantage in establishing standardisation.

(ii) *The Training of Maintenance personnel:* The training of the personnel for a given project should normally start at the equipment manufacturing stage and at manufacturer's workplace. This approach exposes the trainees to the internal workings of the equipments. The understanding of how the equipment is put together is of immense benefit as it boosts confidence at the maintenance stage. Additionally, these maintenance personnels should participate in the installation and commissioning stage of the equipment. Without this approach at the project site, the equipment will essentially be a 'black box' to the maintenance staff.

(iii) Project/Equipment Documentation: This is extremely an important aspect of project execution; poor documentation can be a nightmare to the maintenance staff. Poorly executed projects should normally have comprehensive commissioning records, equipment maintenance manuals commissioning test records, etc.

(iv) Special Maintenance Tools: This should be acquired along with the equipment. Unavailability of such tools will always be a cog in the wheel of proper maintenance as improvisation at early stage may lead to equipment damage. Special tools improvisation may become applicable later in the life of the equipment when adequate maintenance experience must have been attained.

2.2 Maintenance Capability for Power Equipment

Every power system has a number of factors which are peculiar to it. The line length is different and as such the voltage profiles would be peculiar to the power system. Operators would therefore have to study the requirement for voltage control and system stability. Also, the operation of power system requires specialised knowledge of the system behaviour with changing loads and power factors, as well as specialised skills for the control and maintenance of a power system [5].

The level of development and manufacture of heavy equipment in the country is very low, yet PHCN relies on such equipment for its energy Generation, Transmission and Distribution (GTD). There is little in-house engineering development work taking place in PHCN and the number of broken down power equipment is increasing as a result of poor maintenance of same. This is corroborated by the poor performance of PHCN in recent times and the heavy import bill of the establishment. PHCN management has not encouraged maintenance as there is presently no repair and development workshop for heavy power equipment. Skills required for critical maintenance work can only be acquired if vital equipment can be dismantled and re-assembled during maintenance. The total reliance on finished goods imported from outside the country does not give us the opportunity to create jobs for local engineers and to acquire the necessary skills for maintenance of our infrastructures. A policy to ensure that all broken down equipment are repaired and restored is vital for acquisition and development of technology.

3.0 MAINTENANCE PROBLEMS IN NIGERIA

The theory of maintenance and the various types of maintenance as shown in Figure 2 are very well known in Nigerian Engineering environment [6], but such problems like unavailability of spare parts, inadequate release of funds for maintenance purpose, and bureaucracy among others, hinder effective maintenance of the government industrial sector.

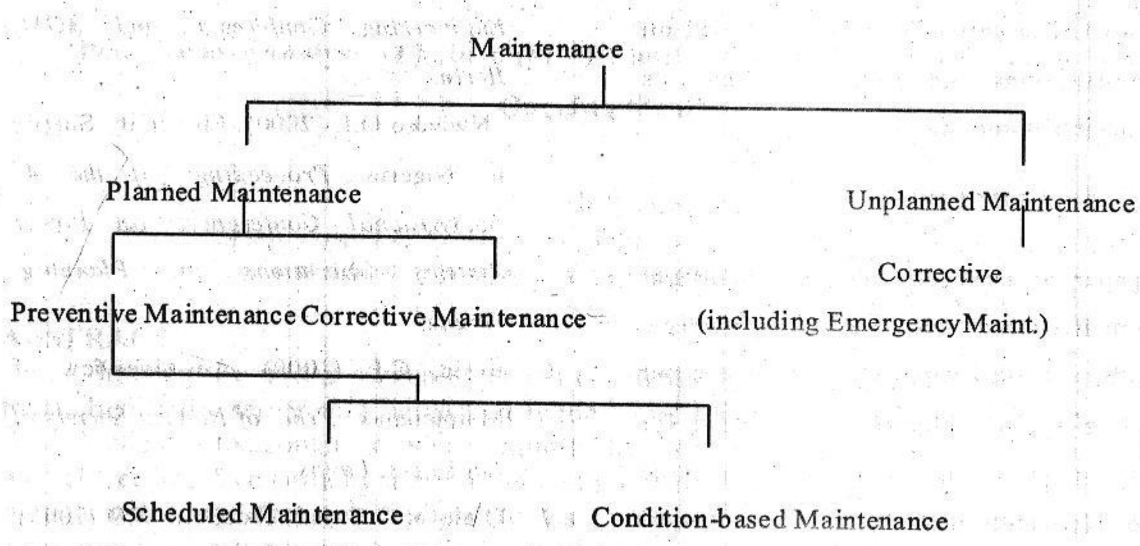

Figure 2: Forms of Maintenance

1. **Scarcity of Spare Parts:** Nigeria imports virtually all equipment and the associated spare parts. Due to the unfavourable exchange rate, it is not easy to obtain spare parts for maintenance.
2. **Lack of Fund:** Most government establishments are not adequately funded with the maintenance demand not being easily met. This frustrates the maintenance department and may lead to absolute neglect of the services [3].
3. **Bureaucracy:** In some government establishments, the fund may be available but due to approval limits set for certain level of staff and/or boards, a lot of time is required for final approval.

4.0 HE WAY FORWARD FOR EFFECTIVE MAINTENANCE

In order to have an effective maintenance culture, there must be:

1. **Effective Management:** An effective management shall be able to ensure adequate stock of spare parts, and reduce bureaucratic delays. Where the game is played according to set down rules, success can be achieved. Defaulters under such circumstances should be shown the way out.
2. **Financial Discipline:** If there is financial discipline, budget and maintenance allocation will be appropriately utilized. This will encourage maintenance staff to put in their best to ensure uninterrupted service [8].
3. **Devotion to Duty:** An effective management shall adequately consider staff welfare and remuneration, which directly affects devotion to duty. In general, staff of private establishments are more devoted to duty than those in civil service.
4. **Training:** Staff need to be continuously trained and retained to meet up with changing technological demands. Training improves the efficiency of staff and therefore increases productivity

Development of Local Test Facilities: A large number of power equipment fails in service because they were not tested in the environment in which they were to be

1. used. The current practice of relying on tests done on equipment by its manufacturers should stop [7].

5.0 CONCLUSION

In this paper, an attempt was made to highlight general maintenance problems. The objectives was to create more awareness and enhance our maintenance culture. Increase in demand for electricity supply in Nigeria with corresponding supply of electricity to meet up the consumers' demand should of course, be the focus. However, poor quality of electrical power is attributed to the malfunctioning of some electrical equipment that has not been adequately maintained as well as the activities of both the consumers and the power utility (PHCN). The basic technical issues relating to operation and maintenance of electrical equipment have been discussed in detail. It is hoped that all these would ensure sustainable industrial activities, safety and manageable maintenance cost.

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