A REVIEW OF MAINTENANCE OF ELECTRICAL POWER SUPPLY SYSTEM

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Abstract

The maintenance of electrical power supply system as the life-wire of human endeavours cannot be over-emphasized. Over the years, there have been lots of hues and cries in Nigeria about inadequacy of the nation's electrical power supply system, right from the point of generation to the end user. The general poor electrical power supply system in Nigeria and the pathetic state of those in government establishment in particular, awareness on maintenance cannot be more appropriate. This paper shall attempt to describe the various components of electrical power supply system in terms of High Voltage (HV) and Low Voltage (LV) supplies with a view to understanding its maintenance in pursuit of technological development for developing countries.

Introduction

The electrical power supply system stands unique for efficient day-to-day operation of human beings in this modem age. At night or in the dark and in the daytime, it is most essential for effective operation, convenience and comfort. Human activities become ineffective, inconvenient and uncomfortable in the absence of electrical power supply. Electricity is considered the life-wire- of modern systems and operations such as education, transportation, industrialization, residential accommodation, computer, banking, government, communication, etc. Modern civilization is based on the ease and efficient use of electrical energy, hence the importance attached to its maintenance.

Maintenance as an activity applicable to all systems (natural and artificial) is to cause such systems to remain unaltered or unimpaired (Okah-Avae, 1990).

There are three main types of maintenance that are discussed in this paper. These include: (i) Routine Preventive Maintenance, (ii) Corrective Maintenance and (iii) Breakdown Maintenance.

This paper will focus mainly on routine preventive maintenance complemented with corrective maintenance as and when necessary. With sustained routine preventive maintenance and corrective maintenance, breakdown maintenance would be minimized.

The electrical power supply system is basically of two-folds, namely high voltage at 330/1IKV and low voltage at 415/240V. The followings are the equipment to be treated under the 330/1 IKV and 415/240V levels.

(i) **High Voltage:** Indoor High Tension (HT) panel, 11KV/415V Transformer, Ring Main Unit (RMU) and associated cables,

(ii) Low **Voltage:** Feeder Pillar, Fused switch, Miniature Circuit Breaker (MCB), etc.

Generation, Transmission and Distribution of Electrical Power Supply System

It is necessary to look at the generation, transmission and distribution of electrical power system in Nigeria before considering its maintenance. The National Electric Power Authority (NEPA) is the sole agency responsible for electric power generation, transmission and distribution in the country. The generation of power is between 15KV-25KV level with two types of generation stations namely:

(i) Gas Fired Engines (Gas Turbines) in Thermal Power Stations located at Afam, Delta, Egbin, Ijora, Oji River, Sapele and Ughelli.

(ii) Hydro Electric Power Stations (Water Turbines) located at Kainji, Jebba and Shiroro.

The machines used are 3-phase synchronous generators consisting of a prime mover (Turbine) and a magnetic field winding on an iron core which rotates inside 3-phase windings ,on the stator. The output voltage is then stepped up to 330KVV132KV for long distance transmission (Francis, 1988).

NEPA operates the National Grid which is the transmission network of the country whereby bulk supply is taken from one point to another at 330KV or 132KV through steel cored aluminum conductors suspended on steel lattice towers. Transmission between towns (50-120 km) is at 33KV. Primary distribution to local sub-stations supplying industrial and commercial consumers is at 11KV and distribution to small industrial and local consumers is at 415V/240V through copper or aluminum conductors supported on metal, concrete or wooden poles.

Safety and Working Tools

There is need for well-equipped safety procedures before any maintenance can be carried out. Employers and employees have the duty to ensure that the place in which maintenance work is to-be carried out is free from dangers which are likely to affect the health and safety of themselves and others.

High Voltage Equipment

The high voltage equipment required is a High Tension (HT) or 11KV panel comprising a number of switches and a transformer to step down 'the voltage before distribution since the incoming voltage is 11KV. It is necessary to know the type of equipment that can be specified for safety reasons and it should be able to meet the needs of the consumer (Zyuzin A., Pokonov N. and Antonov M., 1990).

Safety demands that the High Voltage (HV) equipment be separated from the Low Voltage (LV) equipment, Inflammable materials are not permitted in the manufacture of the HV equipment for safety purposes. It is better and advisable to put HV equipment such as 11ICV panel indoors and the transformer (properly fenced) in the open air.

The followings are considered under the high voltage equipment: (i)

Switch Gear Specification

Oil in the switch gear manufacture is not permitted. Non-inflammable insulation medium such as vacuum and sulphur hexafluoride (Sf_6) must be used.

The panels are also provided with:

(a) Instrument relay such as ammeter, over current and earth leakage relays.
(b) Protection current transformers which are used for protection purposes such as over-current and earth fault protection.

(ii) **High Voltage Metering Panel**

It is usual to specify a metering panel where instruments are mounted. NEPA specifications for the instruments are:

(a) Voltage **Transformers:** One 3-phase voltage transformer is installed. The ratio being 11KV/240V for 11KV system. The voltage transformer is rated 50VA per phase. Another one 3-phase voltage transformer is installed if a check is required by the consumer (Zyuzin A,, PokonovN. and AntonovM., 1990).
(b) **Metering Current Transformers:** Two current transformers with ratios as specified on the load estimates are used for metering. The burden and class of the current transformer is 15VA (Zyuzin A., Pokonov N. and Antonov M., 1990).
(c) **Meter:** The meter normally installed is one trivector meter equipped with maximum demand indicator and cumulative demand indicator on KVA section and a cyclo meter register on KWH, and KV Arh sections.

(iii) **Maintenance of 11KV Panel**

Maintenance of the 11KV panel consists basically of replacement of the various transformers already described if any is burnt, resetting of relays and protection devices such as the tripping units.

Step-Down Distribution Transformer

There are basically two types of transformers in use. These are the dry-type and the oil-immersed type, which are more common. The oil serves as both insulation and cooling medium. The voltage ratio is 11KV/415V at 3-phase SOHertz. Tapping are provided centrally in the high voltage winding to give 10.5% and 5% voltage variations on the low voltage side at no-load condition (Endrenyi, 1978).

The maintenance procedures for the two types of transformers commonly in use are: (i)

Dry-type Transformers

This type of transformer must be kept dust free and protected against pollution. At regular intervals they should be cleaned with bellows or vacuum cleaners. Terminals or bolted joints should be checked regularly. The insulation resistance is normally measured with either 1KV or 2KV instrument or a megger.

(ii) **Oil Immersed Transformers**

The type of fluid used is stated on the rating plate. The maintenance of this type of transformer includes: checking effectiveness of gaskets and quality/ condition of plant, testing the insulating fluid for moisture content and checking/ reactivating the silica-gel and the breather.

Ring Main Unit

The Ring Main Unit (RMU) is a coupling switch or isolator incorporating switches and oil circuit breakers on 11KV system. It allows uninterrupted operation of a system while part of that system is being maintained. This is achieved in a ring circuit where a section of a system is fed from two directions so that a fault in one section can be disconnected without loss of supply to the other sections. The RMU also allows change of load circuit from one system to another. The RMU can be used in both overhead and underground electrical systems. To overhead system, the RMU is used as an isolator or switch for a particular segment of the supply while for underground system it allows coupling of many transformers and maintenance of each of them without interrupting the entire supply system.

Low Voltage (Lv) **Supply System**

A 3-phase 415V supply is used for supplying small industrial and commercial loads such as garages, utilities and electric motors. A single-phase 240V supply is usually provided for street lighting and individual domestic consumers. For general electrical installation of a 3-wire connection:

- Red/Brown-Live
- Blue/Black-Neutral
- Green/Yellow-Earth

In a 4-conductor overhead domestic supply, the neutral wire is nearest to the ground so that it could fall off and drop to the ground without creating any problem. If by mistake, connection to a house is made from phase-to-phase instead of neutral-to-phase, the supply voltage will be 415V instead of 240V with disastrous consequences.

All the light bulbs will blow out and the equipment except those protected by fuses and automatic voltage switches (AVS) will get damaged. The motors and transformers will get burnt.

Under the low voltage supply system, we have:

(i) **Feeder Pillar**

The feeder pillar is a LV panel that feeds loads between phases at 415V for small industrial and commercial supplies and between one phase and neutral at 240V for individual domestic consumers through fuses (100A-800A).

(ii) **Connection of a Generator**

If a generator is installed, it is connected through a changeover switch to the distribution board. A big generator (400KVA or higher) supplying several loads is isolated by a switch gear before the changeover switches (Alexander Kusko, 1989).

Associated Cables

The connecting cables for NEPA incomer to HT panel and to RMU and transformer can be single-core or 3-core armoured cables normally underground. The connection from the transformer to the LV panel may be by 4-core underground cables. It must be ensured that the cables are never damaged or carbonized at the joint, PVC armoured cables should be used as far* as possible (Francis, 1988). The surrounding of the cables must not be water logged. The procedure for maintenance of the associated HT cables is as follows:

(i) Continuity test,

(ii) Phase-to-phase test,
(iii) Insulation test and
(iv) Phase-to-neutral/earth test.

There are special instruments for these tests which must only be carried out by qua! i Heel and experienced electrical technicians.

Conclusion

The maintenance of electrical equipment should not stop at awareness but should be pushed further to arrest poor maintenance of electrical power supply system.

The shift now should move from ad-hoc maintenance approach under unqualified personnel to integrated management approach under qualified engineers that will control decision-making plus all the elements of routine preventive and corrective maintenance so as to avoid breakdown. With this, it is hoped that maintenance and service life of electrical power supply system will be enhanced in a developing country like Nigeria,

Developing countries can accelerate their electrical power supply system by emphasizing learning, linking the educational sector and the rest of the economy more directly and adopting an innovative maintenance culture. This will go a long way in improving the maintenance of electrical power system in Nigeria.

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