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Infrastructural Asset Management and Maintenance of System Health in Power Sector Utilities: An Overview

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Abstract

Asset Management is a systematic way to manage assets and it is important for a firm, company or an industry to monitor and manage them effectively. Power sector utilities involved in generation, transmission and distribution affairs possess huge assets spread across the country and the need to manage them efficiently for achieving better productivity in an economical way to gain better returns on investment. Tracking of assets is a relevant activity for proper identification of the company's assets and the risk management that arise by utilization of certain assets. It also paves way for inventory control and maintenance at reduced costs and carryout life cycle analysis. The need of the hour for the power sector asset management is to optimize operation and maintenance of assets through effective monitoring through information technology and digital engineering interface.

Keywords: Asset Management, Asset Life Cycle Analysis, Infrastructural Asset Management, Power Sector Asset Management

1. Introduction

'Asset' is an economic resource which may be a tangible or intangible and that is owned or controlled by a firm or company to produce positive economic value. Assets form the backbone of any utility and asset management is critical to any industry including power sector industries. Asset management is the process of maximizing the assets to get back the best and maximum possible returns to the stake holders and ensuring asset recovery.

The concept of 'Asset Management' (AM) emerged as a result of development in Smart Grids, invention of new intelligent devices and the de-regulation of power sector industries since late 1990. AM is also a process of getting the maximum return on the investment on equipment over its entire life cycle, by maximizing performance and minimizing the expenditure on capitals and the operations[1].

1.1 Why Asset Management

Asset Management helps the company to keep track of its assets, manage assets at different locations, assists in creating an inventory report, and ensures accurate financial and business dealings of the company.

Infrastructural Asset Management assists in effective planning for the operation and maintenance of the plant and the involved risk management. Proper management of the assets lead to the effective planning and implementation of the management programmes.

An effective Asset Management aims at reducing, eliminating or at least managing the risk of drastic equipment failures which may leads to higher maintenance costs and production losses. An effective Asset Management program minimizes the interruptions in the production and reduces un-necessary maintenance costs. Effective Inventory management is also an outcome of effective asset management.

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Leading asset management Standard ISO: 55000 address the broad asset management and take into fold the organization and its stake holder. The standard provides a framework for leading practices and is a reference for utilities to indentify improvement opportunities through holistic and systematic approach.

The life cycle of assets gets affected by a number of factors such as improper maintenance, poor operational practices, outdated design and specifications of the equipment, older equipment and non-availability of the operation and maintenance manuals etc., thereby ensuring effective integration of the operating systems.

It is well established that as the plant ages, the cost of operation and maintenance tend to increase. Studies have indicated that adapting leading approach with an intelligent asset management practices have yielded benefits and significantly improved the value. Utilities have also envisaged reduced annual maintenance costs of the assets with the best asset management practices. The critical leading practices can transform assets management capability, performance and value.

The assets of the utility are both physical and non-physical in nature and its managing involves creating a data bank of information pertaining to the assets which involves maintenance of records, information related to the equipment, specification, design, day to day operation and healthiness aspects. This data will be helpful to rigorously analyze and diagnose the condition and or failures of the equipment.

Steve McCabe[2] opines that improving asset information and data management remains a big opportunity. Proper risk assessment and mitigation can only be well understood if the right data exists to support it.

2. Infrastructural Asset Management in Power Sector

Presently, utilities are pacing towards a new value chain, augmenting and interconnecting through digital technologies with power and information technologies moving parallel together. These changes in technological markets and the government policies transform utilities and the challenges they face. Achieving excellence in asset management is critical and is the key to optimize returns on investment in the power sector. The aging infrastructure and the rise in the cost in power generation and the need to gear up to the disruptive technologies pose challenges and pressure on the power sector utilities, to invest and maintain the growing and modernizing service delivery assets.

The Generation, Transmission and Distribution wings in the power sector possess huge assets installed and commissioned few decades back and it is essential to keep investment levels of these assets in pace with the growing needs owing to the technological transformations/ advancements world over and often calls for the replacement of the asset bases.

The power sector utilities are gearing up to the circumstances and giving the required leverage for changing and reforming asset management.

Due to the technological advancements and innovations in power sector, there is a disruption in the traditional power sector activities. The shift in the processes due to decentralized power generation, demand side operations for energy storage, rise in electrical vehicles etc., which have changed the way power sector utilities operate. The increased energy demand by the aspirational middle class population which has grown world over has necessitated for more energy demand. The GDP of the nations are also strongly dependent on electricity demand.

3. Effective Asset Management of Power Utilities through Digitization and Modernization

Indian power sector utilities are becoming smarter presently bringing in significant changes in the control and communication technologies in the power networks

Digitization of the interconnected assets in the power utility has helped to effectively monitor the functioning of equipment in one area which impacts the functioning of the equipment in another remote area. This has boosted utilities to maximize the performance of the critical assets thereby leading to cost effective power generation and distribution.

Many Discoms in the country are looking at ways and means to increase operational efficiency and ensuring effective network planning. Several digitization and grid modernization initiatives are being adopted with a focus on consumer service by implementing Information Technology solutions. Discoms are also deploying key strategies and technologies in the grid modernization

programmes and addressing the issues and the challenges faced in its implementation.

Digitization and modernization are being brought in a big way to upgrade the grid performance. The major activity related to the digitization is the implementing and integrating the advanced information technology for planning, operations and solutions. The vast growth in the information sciences in the country which has grown leaps and bounds help to implement the communication technology and digitization.

With the adaptation of these latest technologies the power plant personnel are able to effectively maintain and measure the performance parameters even from a remote location accurately, effectively and rapidly thereby helping better decision making. The fundamental principles of maintenance, refurbishment and strengthening as strategic methods for managing these assets in the electrical power distribution sector are very vital.

Any given electrical distribution network comprises of the primary and secondary plants and hence power sector utilities can be classified into Primary and Secondary plant assets[3].

Primary assets may comprise of steam generating boilers in the thermal power station, over head lines, power and instrument transformers, high and low voltage switchgears and cables etc., Most of these equipment are operated outdoor in extreme to severe environmental conditions. The life expectancy of such equipment will be over twenty-five years. The failure of this equipment often directly affects the disruption of the power supply to the customers. With advancement in digital technology and with the use of sophisticated intelligent electronic devices, power plants are enabled with automated maintenance of equipment through distributed intelligence network.

Secondary assets comprise of equipment installed indoors. This equipment helps to retrieve data from the network, monitor system and helps operator have a good degree of visibility and control of the network. The present day asset management is effectively implemented through a combination of Operation Technology (OT) and Information Technology (IT) modules. Operational Technology involves various categories of devices, sensors, operating software, etc., which are integrated into the system to monitor and control devices, process and events on a real time basis.

Operational Technology also includes Distribution Management System, Supervisory Control and Data Acquisition (SCADA), Outage Management System, sensing devices, measuring devices, motors and drives etc. Though asset management and SCADA are distinct systems, they complement each other.

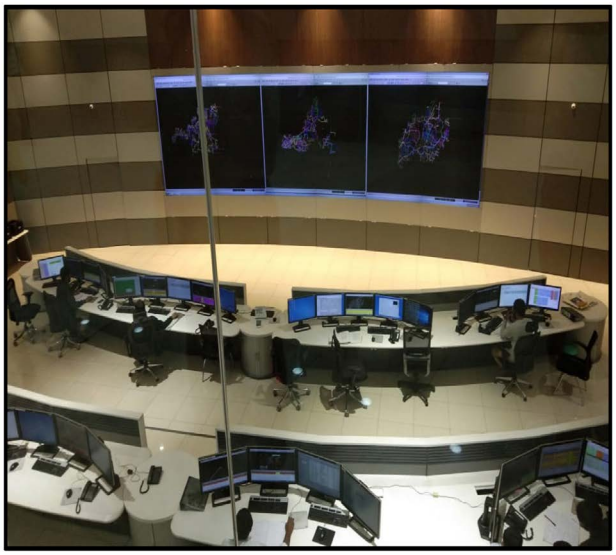

Figure 1. Secondary assets.

SCADA system is very useful to Asset Management since it assimilates all the information of the assets and provides value addition both to the system and operator thereby eliminating the information gap between them. An example of SCADA operating system which is a type of secondary asset is depicted in Figure 1 and its schematic is depicted at Figure 2.

Figure 2. Scada schematic.
(Source: internet)

4. Asset Maintenance in Power Utility

Maintenance practices in asset management may be categorized as corrective maintenance or break down maintenance, preventive maintenance, predictive maintenance and proactive maintenance. Plant managers should adopt appropriate technical and economic strategy (maintenance, refurbishment, strengthening etc.,) critically for the optimum operations with reduction in system 'downtime' for improved quality of supply and revenue earnings.

4.1 Breakdown Maintenance

The most commonly followed one is the corrective or break down maintenance in which assets are repaired only when it stops functioning.

4.2 Preventive Maintenance

Preventive maintenance calls for comprehensive routine tests to be undertaken at least annually for the assets which are capital intensive and time consuming exercise.

4.3 Predictive Maintenance

The utilities have become smarter and with time, predictive maintenance which is a fact based approach adopting advanced OT applications, has achieved importance. The current performance cycle is analyzed for the cause-symptom relationship between the asset and its parameter and based on the conditions of the current parameters, it is decided if the asset needs corrective action.

4.4 Proactive Maintenance

It is a condition based maintenance similar to predictive maintenance but relies upon more analytics. The failure in the asset is predicted much before its occurrence using online and offline test data. The installation costs are very high and have un-predictable maintenance periods which are random.

4.5 Condition based Maintenance

Condition based maintenance adopt many non-destructive analytical techniques to ascertain the healthiness of the assets such as boilers, turbines, RCC and steel structures in power plants etc., Thermographic survey which works on the principle of infrared technique, is one of the important techniques employed on the equipment during service to monitor the temperature profiles on the surface of the equipment under test.

The variations in the temperature profiles on the surface are compared and in case the variation is abnormal rise in temperature beyond the operating temperature, it calls for immediate attention to adopt corrective action to avoid damage of the component due to overheating. Thermographic techniques are employed to check the healthiness of distribution transformers, electrical connections, turbines, motor shafts, rotor, flame temperature measurement in boilers, hot spot survey, switchyard inspection, insulation audit etc., in the power plants.

Non-destructive techniques such as Ultrasonic are employed in a big way for flaw characterization in high temperature boiler components, oxide scale thickness measurement in the boiler tubes, boiler tube thickness measurements, Ultrasonic are also largely used to detect discharges and ionization in switchgear components.

4.6 Reliability based Maintenance

Many factors decide the reliability of assets in the power sector such as age of the assets', condition during purchase, specific wear and tear, environmental and weather conditions, maintenance in field, static and or dynamic load conditions acting upon the equipment etc.,

Reliability Centered Maintenance (RCF) policy is based on the life cycle cost concept and the decision for replacement of the equipment is taken based on techno-economic considerations. From the view point of RCM objective should be to devise a system, which does not need periodic maintenance and at the same time predict in advance possible failures/problems of the equipment.

To meet this aim it is needed to develop equipment which require either no or very little maintenance and on the other hand the concept of condition based maintenance should be implemented. Realization of this objective will result in enhancing availability, reliability and reduction in manpower for maintenance purposes.

5. Asset Management in Power Utility

5.1 Management of Short-term Assets

The short term asset management is categorized for operation and maintenance on daily and weekly basis and outage management if any. These include real-time operation tasks, online monitoring, equipment and network control. In order to develop asset management, taking the distribution processor as the most sensitive element, in the short term, the application must contain all the necessary and detailed information of the asset, which is useful and relevant, leading to the optimization of analysis and actions to be developed.

The application of systems of management of the electrical network like the G.I.S. can help to develop these goals in the short term. Reliable and safe information should be part of the characterization of the asset, among them, location coordinates, date of installation, nominal power, nominal voltage, date of last maintenance performed, operator who performed, number of customers supplied, brand, model and asset failure history should be considered. Online monitoring is done through SCADA systems which provide information regarding the performance of the asset. The classification of asset management as per Swasti R. Khuntia et al.[4] is described in Figure 3 and their details are discussed.

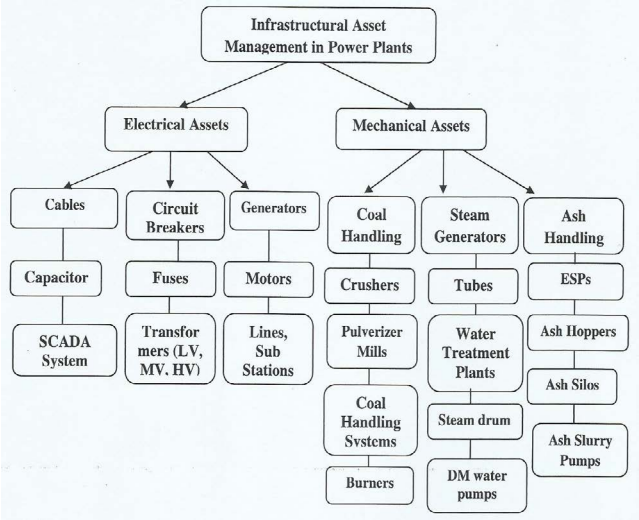

Figure 3. Classification of asset management.

5.2 Medium Term Asset Management

The time frame ranges from few months to a year for medium term asset management. This should be used to study aspects related to the remaining life and handling of investments on the asset or fleet of assets. For distribution transformers, actions based on the maintenance of the assets must be established and applied, and an option is to use maintenance focused on reliability.

The maintenance tasks should be programmed and evaluated not only according to the times involved, but also in terms of the costs invested. Different reliability engineering tools are used to implement an optimized maintenance strategy. Another feasible tool to use is the so-called asset health index, which can cover the substation to which the distribution transformer belongs, together with all its components, or the distribution transformer as the only element.

5.3 Management of Long Term Assets

The time frame ranges from one year and beyond for long term asset management. Long-term scenarios typically develop information analysis features for asset renewal decision making. The distribution transformer is an asset which, with adequate maintenance, can have a life of approximately 30 years. In the long-term asset management strategies, the knowledge developed based on short- and medium-term strategies is fundamental. Strategic risk management should be considered in order to evaluate the way assets are exposed and thus know the critical assets, those that require greater maintenance and money investment, during the use of the asset. It is important to note that assets that are used according to the latest and proven technology offer better returns[4].

6. Maintenance of Electrical Equipment in Generation, Transmission and Distribution Sectors

The restructuring of power sector into generation, transmission and distribution wings has posed a series of constraints on the asset management, to provide quality, and uninterrupted power supply to the consumers. Presently, power sector have incorporated the right blend of effective management, engineering skills and information technology which are operated in tandem to help the power sector to overcome challenges of proper alignment of asset management for fulfilling customer requirement satisfactorily and also to meet the corporate objectives.

In all the 3 wings of the power sector areas, field visits, evaluation, testing and performance studies can predict assets' life time and provide support to maintenance methodology. Testing of assets as per standards can ensure an outcome solution and real time data to arrive at accurate conclusion about the remaining life of components and to plan to take necessary efforts, precaution and investments into maintenance.

There is a need to address issues related to installation of equipment, electrical maintenance and testing issues related to low, medium and high voltage electric circuit breakers, switchgear and electrical power transformers etc., Maintenance issues concerning the proper application, installation and maintenance of these types of equipment with a strong emphasis on safety which is of prime importance.

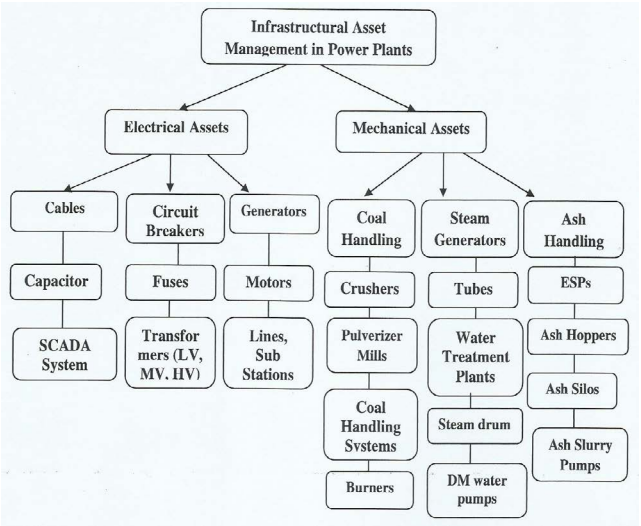

Figure 4. Asset management in power plants.

Electrical maintenance personnel need to have a strong knowledge base related to the aspects electric power system design, theory, types of equipment most commonly used in the utility, industrial, commercial and institutional applications, basic circuit breaker, transformer construction, electrical safety, and common and maintenance techniques. The power utility companies can effectively implement asset management programmes primarily through Implementation of ISO 55000 Standard. A schematic is provided on asset management in power plants in Fig.4.

The analyses on following areas are also needed to be addressed for effective asset management[5]:

a) Digital transformation for asset management
b) Smart asset management in energy networks
c) Asset Integrity Management (AIM) system
d) Risk based inspection for asset maintenance
e) Preventive maintenance using remote sensing instruments
f) Risk management
g) Improve asset life cycle modeling and cost
h) Prioritizing risks in asset
i) Investment planning
j) Big changes as an opportunity in asset management
k) Making the right investment decisions on assets
l) Driving innovation in managing assets

7. Conclusions

Asset Management maximizes life time of assets, prevent outages and other disturbances, thereby optimizing the maintenance effectively and efficiently. Reforms in the power sector have compelled utilities to review the asset management and business prospects that are profitable and efficient. Appropriate asset maintenance management is a priority. Refurbishment/ replacement and strengthening of assets are to be followed as a continued process in the utilities.

New and advanced computational methods can help the transmission and distribution sector to improve reliability of the assets, reduce the risks involved and save money. Of late certain asset management decision models are being employed which play a vital role in capturing and conveying the knowledge thereby assisting the operating engineers to incorporate the same into asset management plans. The transmission and distribution sector are into using new technology devise for remote controlling and monitoring equipment in an efficient manner.

As the cost of remote monitoring and analytical software seems affordable, employing these make both the T&D companies' asset management more productive. Advanced analytical systems using real time performance data and predictive algorithm can help the firms to prevent failures, have effective maintenance at low cost, avoid premature replacement of assets and create a knowledge base of the in-house experts.

The Information Technology and innovative Software integrated with the systems, deal with exponentially growing variety of retrieved data processing, and with use of WAN, LAN etc., enables big data processing with predictive and prescriptive analytical solutions. Real time

automation has also enabled decision making in power sector assets' operation and maintenance[6].

8. Acknowledgement

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