Engineering and Technology Journal e-ISSN: 2456-3358

Volume 09 Issue 01 January-2024, Page No.- 3333-3342

DOI: 10.47191/etj/v9i01.12, I.F. – 7.136

Risk Management in Nigeria Electric Power Industry

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ABSTRACT: Most industrial and domestic electricity users are looking for electricity utility providers that meet their industrial and domestic performance needs and can be reliable. Due to maintenance and poor management /support systems, the Nigeria electric power industries are not able to meet the customers, requirements. Major causes of customers' dissatisfaction are often traced back to unexpected failures leading to unexpected costs. However, with proper consideration of risk management in the maintenance policies, the number of failures can be reduced and their consequences minimized. Base on persistence power failures and the present deregulation threats in the Nigeria electric power industry, an approach for integrating risk management in the maintenance system is sort. The importance of FMECA failure management, measures and strategic management to facilitate easy risk management implementation in maintenance function is discussed. An approach is suggested for use of reliability tools, LCC and Pareto simulation waste process management, coordination and control to reduce risk. This paper establishes the importance of a well planned requirement specification and the need to analyze and interpret risk analysis results, for maintenance management.

KEYWORDS: Propelling, Risk management, maintenance, reliability tools, measures, Nigeria electric power industry.

INTRODUCTION

Maintenance process has been taken for granted for some time now in Nigeria electric power industry, especially by the managers, maintenance and operating staff, and the executives. But there are many opportunities to improve maintenance and even reduce costs. The main purpose of this paper is to make the Nigeria electric power stations position themselves to take the advantage of this. External forces have made this imperative. Competition is a power put outside force; hence there is a need for conscious decision to find new maintenance approaches. Armed with a good maintenance plan, operation will have better tools to interpret equipment, plan for maintenance and perform work in a reduced cost fashion, the challenge to introduce the appropriate degree of innovation into an ambiguous environment to improve managing risk and cost. The general lesson of RCM is condition monitoring (CNM). Organizations with CNM philosophy are reliable [1] points out that little or no CNM , and absence of follow-through on the insights provided by monitoring, are the trade mark of unreliable and unsafe operations. Failure to act on CNM adds risk. Understanding problems and alternatives enable us to select alternative options. Organizations are more successful if it embraces the future and risks by making the best possible decisions with the available information. As crisis decreases, overtime , low productivity work, material expense and service expenses fall with time., long enough to capture secondary cost factor. As production unit increases more MWH are produced at less unit cost. The decrease in unit production cost due to increase availability is a major benefit. This paper emphasizes the importance of risk management characteristics for ensuring failure free operation in Nigeria electric power industry. It is argued that risk maintenance policy decisions will facilitate reliability and availability, reduce risk associated with unreliability caused by downtime of electric plants. A need for effective and efficient control of the information flow, failure management and continuous improvement in maintenance processes were identified as critical success factors.

Risk management is an organized means of identifying and managing measuring risk and developing, selecting and managing options for handling these risks. Several tools are available to assist maintenance in managing risk in technical areas, understanding danger signals that may indicate that maintenance function is off track, and prioritizing corrective actions as necessary. Risk management is not a separate management task activity assigned to a risk management department, but rather is one aspect of sound technical maintenance management programme. Many of the systems engineering management technique (technical performance measurement, configuration management, template, trade-off analysis, etc.) are also risk management method [1]. Risk management can be described as:

(i) A formal process by which risk factors are systematically identified, assessed and provided for:

(ii) A formal systematic method of management that concentrates on identifying and controlling areas of events that have a potential of causing unwanted change; and

(ii) Risk management, in maintenance content is the art and science of identifying, analyzing and responding to risk factors throughout the life cycle of a plant in the best interest of its objectives.

Proper risk management implies control of possible events and is proactive rather than reactive. An example, activities in maintenance requires root cause of failure analysis. The schedule of activities is still traditional time based, which is reactive. At the time of maintenance, the maintenance managers will reduce not only the likelihood of an event occurring, but also the magnitude of its impact. The utmost purpose of risk management is risk mitigation which act as reversing the uncertainty with its significant impact on objectives.

Risk mitigation requires risk analysis in order to determine the impact on maintenance, hence the operational plant. Risk analysis includes:

(i) Highlighting the demand for value of money and quality of performance of operating plants

(ii) Increasing reliance upon operating plants;

Expectation that innovation and proactive methods of maintenance will be achieved; requirement for credible and sustainable organizational leadership capable of consistent realization of organizational objectives, and maintain a value of certainty, performance and effectiveness.

CONCEPTS

Risks are the failure to meet the forecast, plant capacity/ available. These failures may be due to inadequacies in plant maintenance. In some cases the risks may be perceive as insignificant, and so the risk is ignored.

BACKGROUND TO THE PROBLEM

The most challenges facing the Nigeria electric power industry is when to pull out and re-capitalize or invest in existing facility to restore reliability and performance. Effectively eliminating characteristics not effective in maintenance engineering programmes, doing so poorly (or not all) less favourable (downtime), driving profit down more quickly. When cots become unpredictable, operations become less economic, and finally-uneconomic. Risk managing increases in scheduling unreliability and allows a company to determine facility end-of-life by technology and mission obsolescence means. The Nigeria electric power industry plants are aging, hence increasing generating reliability with small capital investments will provide attractive short-term earnings opportunities. For these plants, operating costs are high –as are costs of capital and risk. These plants can only be competitive only by keeping their total costs down, this points to improved operation and maintenance (O and M) using age exploration, that is failure analysis of the plant and equipment. This will involve risk management. Extracting capital from the power stations by means of deferred maintenance should never be done lightly, or unconsciously, as has happened in the electric power stations, strapped for cash.

By profiling typical plant systems to understand their technology and basic maintenance, RCM-based bench mark comparisons can help establish appropriate cost levels and identify effective methods for risk management and control cost. Often plant and equipment vendors do not offer product failure information. A time problems develop based on owners specification, maintenance performance, and other responsibilities. The Nigeria electric power industry has not included:

(i) Performance monitoring recommendations to achieve reasonable performance

(ii) Failed to act on known information and have been increasing problems ; losses

(iii) Have serious equipment shortcomings : uneconomically pursue an incompetence

(iv) Cannot meet their obligations to the public; and

(v) They have not conscientiously engaged with quality suppliers in frank discussions about equipment, problems and expectations. This could be where they could have learnt about operating limitations, despite literature and training.

The Nigeria electric power stations maintenance staff is expected to possess a high level of maintenance awareness, but this exceeds reality in the present circumstances. Between vendor guidance and informal learning, the plant maintenance staff and maintenance and maintenance mangers carry on with inexact, unspecified programmes . In most case, maintenance works are merely inferred from work practices. Maintenance modes -even those structured around CMMS and work practices equate to define maintenance processes. Some organizations do work in regulated environments, and still do not have process impact [1]. ISO 9000 certification has driven maintenance process documentation and definition. Without a strategy, maintenance cannot be developed and grow with competitive pressure and cost – baseline budgeting systems. This maintenance strategy suited the Nigeria electric power industry for the present. Today’s maintenance strategy , technology, and theory are changing expectation.[1] points out that when maintenance schedules are reduced to optimal task list, they are accumulate back logs. This justify routine overtimes hours, budgeted across the board. Maintenance can then work all the overtime anyone wants. The only problem is that no one wants to work PMs. In part, this is because planned work can be deferred – ‘prioritized’ and could justify overtime for it. Only emergencies warrant non-routine expenses, so planned work goes begging and undone. Discipline is managing the backlog is what is missing. A better prioritization method would be activity based. All activities need to be ranked for common resources. The automatic deferral of PM to crisis is a fundamental maintenance paradox. Priority work needs to be value-based tools that can restore credibility to a maintenance system. As the Nigeria electric power industry has constantly experienced that the customers increasingly emphasis demand on electricity reliability and availability, predictability, quality, maintainability, and LCC of the plants and equipment could be a competitive advantage. As a result, there is a need to implement and integrate systematic and formalized risk management into maintenance function.ith this background, this paper discusses fundamental issues in implementation of risk management tools and methods in maintenance approach to enhance performance efficiency, to reduce downtime and unreliability. Hence to increase satisfaction and needs, this approach is expected to create a win-win situation for both the Nigeria electric power industry and the customers.

RISK MANAGEMENT

Risk management can provide a structured way of being flexible. Flexibility is needed to ensure that the best safety decisions are made by each operator for his particular system, taking into account power stations plant and operating conditions and the most recent proven technology. A

Structure that can researchable ensure that decision that impact safety and environmental protection are made consistently and in a defensible manner that can be readily communicated to all affected parties. Risk management is the basis for assessing the condition of system and measure the relative impact of proposed actions to improve the condition, the structure processes of risk management allows the investigation, analysis and identification of the most important threats to the public, the share holder and to reliable business operations. It allows the evaluation, comparison, and selection of the best ways to reduce and control those threats. Risk management is much more than the technical models used to calculate probabilities and consequences to be used as an alternative regulatory approach, activities institutionalized into the way that company conducts its business on a day-to-day basis.

MODELS AND THEORY

Risk is a measure of probability and consequences of not achieving a defined project goal. However, it is now generally accepted that when risk is considered, the consequences of damage associated with failure must also be considered. While formal risk analysis procedures deals with the; known unknowns', there is also the issue of the 'unknown unknown' here, only the quantitative assessment usually provides formalism and structure for selection strategy alternative and is a major element in the decision-making process. Conceptually, risk can be define as a function of uncertainty and damage, that is,

Risk= f (uncertainty, damage)

In general, as either the uncertainty or damage increases, so do the risk. Both the uncertainty and the damage must be considered in a risk analysis.

Since risk actually constitutes a lack of risk knowledge of future events, risk can be defined as the cumulative effect that these adverse events could have on the maintenance objectives. Future events (or outcomes) that are favourable are called opportunities, where as unfavourable event are called risk. Another element of risk is the cause of risk. Something, or lack of something induces a risky situation. This is denoted as hazard. Certain hazards can be overcome to a great extent by knowing them and taking action to overcome them. A large hole in road is a much greater damage to a driver who is unaware of it than to one who travels the road frequently and knows enough to slow down and go around the hole. This leads to the second conceptual Equation:

Risk= f (hazard, safeguard) (1)

Risk increase with hazard but decreases with safeguard .The implication of this Equation is that proactive maintenance can be structured to identify hazards and to allow safeguards to be developed to overcome them. If enough safeguards are available, then the risk can be reduced to an acceptable level. Sometimes people consider risk analysis and impact as the same. Mathematically, impact of risk can be written as:

Impact of risk = (likelihood of risk) x (consequences of risk)' (2)

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The methods for identifying risk are numerous. Any source of information that allows recognition of the potential problem can be used for risk identification. These include, system engineering documentation, life-cycle cost analysis, baseline cost estimates, models, benchmarking, brainstorming, decision drivers, Pareto analysis, etc.

Uncertainties that may impact on maintenance include:

(i) Technical-changes in technology, changes in state of art, design issues, operational/ maintenance issues; and
(ii) The technical risk related to utilization of technology and the impact it has on the direction of maintenance.

Typical tools for use in risk analysis are:

Risk priority number (RPN), Pareto analysis, Failure mode effect analysis (FMEA)/, Failure mode effect and criticality analysis (FMECA), root cause analysis (FTA), life cycle cost (LCC) , ETC. Risk can be simply modeled as the interaction of two variable ; Probability of failure (P_f) and the effect or consequences of the failure (C_f). Consequences may be measured in terms of technical performance cost or schedule. A simple model can be used to highlight areas where probability of failure (P_f) is high (even if there is low probability of occurrence).

Mathematically, this can be expressed as the union of two sets, (P_f) and (C_f).

Risk(R) in mathematically defined as [1]:

R=Probability x consequence (3)

Where failure effects determine consequences. Analytical data collected from actual experience, industry data, failure libraries, vendor literature, similarity, comparisons, or published failure studies quantify failure probabilities. Knowing failures effect completes a risk assessment. However, risk itself has different measures. Overall equipment failure is meaningful, calculable, and measureable. FMECA, FTA provides system measure-perspective risks management tools. Overall failure 'risk' for any major plant equipment, component, or integrated system could be assigned a numerical value at the design level. For example, the overall 'mission success' goal for a system might be set at 0.995. From this a FMECA of all system equipment –including supporting subassemblies and components-could then be developed and if the overall reliability did not achieve the mission established goal, then 'criticality analysis '' could identify reliability loss contributors to mission failure. These contributors could be re-evaluated and the largest risk re-apportioned as a design tool. Sub-assemblies or components in which failure –risk is high or which offer opportunities for risk reduction are improved until design-risk goal is achieved. Risk-allocation looks at the desired final product and identifies an overall target failure risk. It is broken down to the system and component level, where FMECA identifies the main risk drivers. Design changes (substitution or redesigns) can address and improve overall mission risk-systematically on a bought [1].

FMECA is a powerful analysis method involving two elements of risk, namely failure frequency and consequences. Sometimes the possibility of detecting the failure is included. FMECA analysis concentrates on identification of the events and frequency resulting in failures and analyzing their effects on components and systems [2]. [3] Points out that the analysis and design-out of the failure cause or correction actions has to be done in product design.

Although FMECA analysis has been performed in industries for many years, only recently have efforts been initiated to formalize and systematize the analysis process. [2] noted that results from the analysis are gradually becoming popular and used more frequently. Such results provide a basis for decision making such as recommendations for preventive maintenance (PM), spare parts and maintenance tool (both for commissioning and exploitation phase), documentation (including procedures, routines, and checklists for installation, failure diagnosis, maintenance etc) and life cycle costs LCC) predictions. The analysis also serves as a basis to evaluate warranty considerations, maintenance warranty programmes, modifications and upgrading of existing products, customers training, and feedback to involve parties etc.

RELEVANCE

Electricity power exists because there is a customer who is willing to pay for and use the product. An electric power industry exist because the product needs to be made and because there is a market and customer for its product. In order to deliver the product or the required function, the utility company has to maintain its plants and equipment and provide the required support to meet expected performance demands. This paper proposes the need to be managed and organized. Suitable organizational systems and leadership therefore have to be in place to manage the maintenance work processes. This can be referred to as 'customer pull' on plant and equipment maintenance process. In this case, the product, electricity is generated and transmitted on to the customer's terms. Customer's needs, wants, and preferences are, in this case, integrated into the maintenance plans and efforts and s, the serve as the drivers of MWH generation and organizational development. In the other extreme, the organization can 'push' 'MWH' into the customers, based on what is technologically possibility, and more ever from the organization without the taking customer's needs, wants and preferences into consideration. [2] Maintained that this reverse relationship in what is deferred to as technological and organizational 'push'. However, whether the driver for product and organizational development is a pull or a push process, the increased market pressure in respect of cost, time and performance forces a need for effective and efficient distribution of, and access to, product and work process-related information, and for more proactive , effective and interactive information use.

It is important to integrate customers' needs, wants, and preferences into maintenance as easily as possible, as during this stage. It is easier to influence product LCC and customer satisfaction, this paper argues that integration of risk management in maintenance functions is fundamental in accomplishing and ensuring the success of a proactive maintenance development and for reaching the goal set at the onset. [2] Maintained that support is needed to compensate for product unreliability, loss of product performance quality and effectiveness, reduced product output quality, lack of usability etc.

EVALUATION OF RISKS

[4] maintains that a satisfactory evaluation of risk can only be done by a group. As far as possible, this group should represent people who are likely to have a clear understanding of the failure mechanism, the failure effect (especially the nature of nay hazards), the likelihood of the failure occurring and what possible measures can be taken to anticipate or prevent it, This group should also include people who have a legitimate view on the tolerability or otherwise of the risks.

This should include maintainers and operators who are in direct contact with the hazards, as well as the management, who are usually held accountable if there is any injury or breach of any environmental standard. In a properly focused and structured fashion, the collective wisdom of such group will do much to ensure that the organization does its best to identify and manage all the failure modes that could affect safety in the environment. In this regards, it should be noted that the worldwide trends toward the laws, which say that safety is the responsibility of all employees, not just the management. Responsibility of this group who are the people at risk could reach consensus quickly when dealing with direct safety hazards. In the case of environmental hazards, it is the society that is the likely victims and many issues involved may be unfamiliar with this group. The group is expected to consider whether a failure could breach an environmental standard or regulation beforehand.

[4] points out that failure mode which has a safety or environmental consequences, a proactive task is only worth doing if it reduces the probability to a tolerantly low level. If a failure could affect safety or the environment, the RCM stipulates that it must be prevented. Where this cannot be adequately anticipated or prevented, a change in the operating procedures or modification should be made. This is classified as redesign. The objectives for redesign include:

(i) To reduce the possibility of the failure occurring to a tolerable level; and

(ii) To change things so that the failure no longer has safety or environmental consequences [4].

Reliability Engineering details are repair time data can be converted into statistical format using Win smith Weibull software for use in reliability calculations [5]. Often variable condition requires Monte Carlo simulations to find how cost will vary with time and different grades of influences. Monte Carlo techniques uses random numbers to solve the problems and spreadsheet, [6] reliability modes using actual failure data and repair times give systematic availability, reliability, maintainability and other operating system details which allows construction of costs and tradeoffs [7] Monte Carlo simulation techniques are used to join probability distributions and economic data to solve problems of uncertainty using spreadsheet techniques [6]. Monte Carlo results are similar to real life spreadsheet programmes such as Excel ^{TM} or Lotus ^{TM} or specialized ad-in programmes such as @ Risk ^{TM} can add uncertainty to the calculation [6].

MANAGING FAILURE WITH RCM

RCM processes assess safety consequences at the most conservative level. If it is reasonable to assume that any failure mode could affect safety or the environment, it may be reasonable to subject it to further analysis. The likelihood that someone will be injured is taken into considerations when evaluating the tolerability of the risk [4]. The RCM process is to establish the most effective way of managing each failure in the context of its consequences. This is done in the form of predictive and to prevent it or mitigate its consequence. Protective devices which are designed to deal with the failed or shutdown failing state (alarms shutdown and relief systems) are built –in failure management systems. It is better to assess the system as if this protective system is not there, that is, the analysis is carried out from comprehensive and appropriate zero-base. RCM process provides a comprehensive strategic framework for managing failure. This framework is shown in Figure 1 [4] and it:

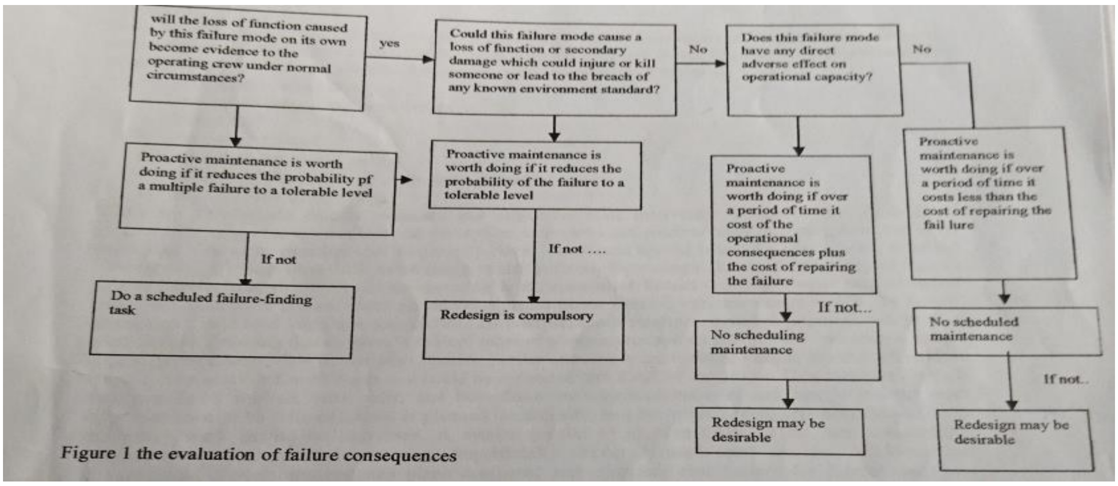

Figure 1 the evaluation of failure consequences

Figure 1: Evaluation of Failure Consequences

(i) Classifies all failure in the other consequences. In so doing it separates hidden failure from evident failure, and then ranks the consequences of the evident of failure in descending order of importance ;
(ii) Provides a basis for deciding whether proactive maintenance is with doing in each case; and
(iii) Suggests what action should be taken if a suitable proactive task cannot be found.

RCM provides three basic strategic options to address failure, time based maintenance (TBM), condition directed maintenance (CDM), and operate to failure (OTF) and no scheduled maintenance (NBM) for non-specific maintenance. RCM can be used to evaluate and rank design modification requests, separating ‘nice’ to do ‘from’ ‘must-do’ modifications by objectively documenting risk. The best time to perform RCM analysis, done concurrently in computer data base format, can help focus the failure event analysis on facts, as well as document other potential, hypothetical and real, failure modes discovered during investigation. In RCM failed states are known as functional failures because they occur when an asset is unable to fulfill a

Function to a standard of performance which is acceptable to the user. Hence this include partial failures, where the asset still functions but at an unacceptable level of performance. RCM provides a standard, common methodology for assessing , ranking and evaluating any maintenance environment, Avoiding rare failure events- the root cause of most heavy production and financial losses-are the major ‘controllable benefit’ from an RCM plan. Plants with high performance records practice risk minimization strategies. Conversely, plants with spotty records are those that fail to follow operating and maintenance practices that help to manage risk, in the absence such strategies losses are suffered. Steady consistent performance, low-cost performance, safe and low-risk performance are what is needed. A complete RCM analysis is to the 80/20 rules, events can be identified and used, based upon experience. RCM for an existing facility is a posterior assessment-experience limits the scope of the review and focuses on value. New facilities can be reviewed using a priori RCM, utilizing a variety of formal reliability engineering tools, including FMECA [1].Projections of likely problems, availability, and reliability and maintenance costs can be generated based solidly on analysis. FMECA and fault tree assist trouble shooting by establishing relative probabilities of what can go wrong. High –probability events can be checked first. They also provide failure symptoms that can validate actual failure causes. FMECA indicates sources of failure, benefiting future trouble shooting. Reliability engineering tools help quantify and develop risks using FMECAs. FMECAs can quantify risk of any particular catastrophic event. Once risk are quantified (by extracting them from existing designs and using industry information), O &M can manage risks. A complete assessment -based on industry event frequency and corporate plant risk management programme will identify risk level and help focus available resources where they will do the most good.

MEASURES

Measures need to focus on risk and economic importance. Safety (accidents) or lost generation measures are most difficult. Maintenance costs are known at the generating unit levels, but their allocation downward to equipment is typically unavailable. To quantify risks, consider such things as:

(i) Unit force outage data;
(ii) Equipment emergency work orders;
(iii) Overtime;
(iv) Special part usage;
(v) Insurance claims and audit; and
(vi) Industry experience

There are simple default measures and subjective staff interviews. Operation and their direct maintenance support have excellent risk perception. Interviews can confirm other operating data. Industrial experience is also an excellent tool to quantify risks. Experience around plants for many years, knowing how they are run, and what fails, helps interpret risk patterns. Operating risks can be managed as long as they are known [1]**.** At an operating level, economical factors (corporate wage rate, historical costs, and trends) are known. Total system/equipment hours worked, maintenance (CM, PM) by hours, must be kept. Knowing that a system‘s ratio of reactive maintenance and its competitive operating costs are high suggests finding how competitive operate similar systems or performing general benchmark studies.

Plants follow costs and work hours and could be separated into PM/CM categories. Cost measures include total man-hours worked, total costs and how these are allocated between and among various work, emergency work should be addressed. A system profile of planned CNM, TBM, and on-condition maintenance (OCM) offers lowest cost. Superficially similar systems can have very different cost characteristics .System maintenance plans and compares and contracts cost factors for future needs and reference [1].

System operating costs are the obvious summary performance measure. System level cost measurement is the minimum level to ensure that unit performance expectations are measurable. Usually, a system meets minimum safety standards and support pre-set production levels. All measures start with operating goals. Awareness of the capabilities, are helpful in establishing meaningful goals. They key is to find a parameter that provides improvement focus. As deregulation progresses, generation reliability, and cost per

MWH takes greater importance. These integrating measures give health overview. For individual units, opportunities must be evaluated in terms of specific mission goals. Measurement capacity depends on the organization (and stations). CMMS and risk management capabilities. There is a level of risk with production. In the absence, of ‘ near miss’ programme a level of risk identifications could be traced by two measures that correlate system equipment emergency-work orders (WOs) and overtime. These indicate the degree to which unplanned events influence system performance. This indication can serve as red flags [1].

OPTIMIZING STRATEGY

Many secondary considerations go into scheduling of a heavy outage, such as turbine. This includes availability of other units, overall load, reliability, scheduling of replacement power and services, and value of the deferral in present value terms. With the recognition that outage intervals may have been nominal conservative, methods to extend outage intervals (While managing risk) are considered. Conditional probability method is available in this case. From RCM perspectives, a single great potential savings comes from the systematic examination of risk that comes from incrementally extending an outage period from known benchmark. The five –year turbine standard was considered reasonable safe but companies are shedding the known safety of this interval to take overhauls to seven, nine and even longer nominal intervals. As they do this seek to manage their risk with increased use of condition maintenance (CNM). Extending large machine outage intervals systematically is an obvious RCM capabilities Overhaul intervals are typically based on accepted standards that represent a composite wear out picture for many components. Once established, these intervals will go unchanged for long periods, only the recent drive for competitiveness, and the demonstration by a few independent power producers (IPPs) that overhaul envelops can be stretched , has changed this perspective[1].

Points out that with today’s emphasis on CNM and life-extension, plants are extending intervals, supplement known aging problems with specific monitoring to assess the development of specific problems. Bearing wear , for example can be monitored by a combination of oil monitoring for Babbitt and particulate products, visual bearing inspections (through removable caps), vision machine (VM) and trending, and in-situ dimensional-wear measurement.

The combination is effective as a physical bearing examination for diagnostics. All that is about to know can be inferred from the tests, Bearing can be individually removed and inspected during light outages. Blade assessment can likewise be predicted from stage efficiency and overall performance tests. Bore scope examination (on newer designs with removable ports) is also an option. But the assessment strives to extend intervals by using aging experience and intelligence to perform secondary condition directed monitoring (CDM). Extending large machine outage intervals systematically is an obvious RCM capability [1]. Outages affect unit availability and constitute the most expensive maintenance budget period. RCM reviews simplify and standardize outage intervals to minimize them and maximize benefits. Getting outage work-scope, formally reviewing them for applicability, effectiveness and cost/benefit value greatly benefit outage scope and budget management. For units that maintain extensive outage, work scopes on a routine basis, the RCM screen s virtually identical to that performed for existing PM programmes. Outages are sometime only partially planned. Consistency and productivity of outage workloads comes with thorough failure –based work review for value. Engineering must provide analytical parts life-extension and aging studies to support interval. Computer maintenance management system (CMMS) information must be downloaded then uploaded. Without failure forecast it is extremely difficult to identify problems, measure progress, and achieve success. When overhaul limits are eliminated and age exploration undertaken, equipment lifetimes increase significantly resulting in quick economic benefits and lower risk. Considerable achieved analysis, detailed mathematical failure conditional overhaul gradually emerged. These results can be applied to most industrial maintenance applications. For major equipment overhauls (boilers and turbines) extending an interval by even a few days can have value. Age exploration in new equipment begins by removing parts from service for examination. New –failure mechanisms, premature aging and other unanticipated failure mode evidence require immediate attention. Over the long term age exploration provides the basis for predicting how much service a given component can support. Life extension is done when the ultimate service life of the equipment maintenance decisions. This has found regular application in electric power industry. There is need to improve part cost. Performance in electric generating plant maintenance, legitimizing age exploration, resolves this cultural problem.

Effective age exploration requires:

- (i) Awareness of part characteristics;
- (ii) Documentation (usually via CCMS);
- (iii) Engineering assistance; and
- (iv) A corporate environment that encourages learning.

Maintenance practices needed for risk management include:

- (i) Tailored performance plans based on vendor recommendations and field characteristics;
- (ii) Identifying problems easily;
- (iii) Addressing identified problems while minor, before the final failure phase;
- (iv) With redundancies in place or risk managed and on a timely basis;
- (v) Planned replacements of known age-limited parts, including lubrication; and
- (vi) Quality parts and competent service.

Plants and equipment become uneconomic, when they become unreliable. The content of reliability depends on operating mission. As items age, age based modes failure probabilities increase. Eventually, failure increase. Managed carefully, the overall failure rate of equipment can be controlled.

FAILURES AND OPERATIONAL CONSEQUENCES

Nowadays, most legislations governing safety merely demands that users are able to demonstrate that they are doing whatever is prudent to ensure that their assets are safe. This requires that users of assets to be able to produce documentary evidence that there is a rationale, defensible basis for their maintenance programmes [4]. Specific tasks are done on specific equipment intervals as demanded for some regulation. The primary function of most industry is connected in some way with the need to earn revenue or support revenue earning capability of the organization. The magnitude of these effects depends on how heavily the equipment is loaded and the availability of the alternatives.

[4] States that generally the failures affect operations in four ways:

(i) They affect total outpour. This occurs when equipment stops working altogether or when it works too slowly. This results either in increased production costs if the plant has to work extra time to catch up, or lost sales if the plant is already fully loaded;

(ii) They affect product quality. If a machine can no longer hold manufacturing tolerance or if a failure causes materials to deteriorate, the likely result in either scrap or expensive rework;

(iii) They affect customer service. Failures affect customer service in many ways; and

(iv) Increase operating costs in addition to the direct cost of repairs.

As can be noticed, the consequences of failure tend to be economic in nature, so they can be evaluated in economic terms. The overall economic effect mode which has operational consequences depends on two factors:

(i) How much the failure costs each time it occurs, in terms of its effect on operational capacity plus repair costs; and

(ii) How often it happens.

If the consequences are likely to occur, in other words, to assess the economic impact of these failures, need to assess how much they are likely to cost to cover a period of time.

Failure and failure costs can be influenced by operating conditions, installation conditions, and maintenance condition [8].

In case of a failure mode with safety and environmental consequences, the objective is to reduce the probability of failure to a very low level. In case of operational consequences, the objective is to reduce the probability (or frequency) to a very economically tolerable level. There are two failure perspective focuses-function and component. The functional perspective expresses what a component does, the component perspective, and how it deteriorates [1].Functions affect work, performance. Failure translates as lost function. Functions are required while operating plants. When functions break or are lost, failure is diagnosed, located at the source, and the required parts fixed. Hence one problem is to identify the functional problems, the other, tracing it back to its physical source. Success in managing failure depends on organizational diagnostic skills. Making corrections to components and parts to restore function and performance is the ultimate focus of any maintenance strategy. Failure analysis is developed from failure the failure evidence. This will be found ultimately in failed components and parts, and the hierarchy and boundaries in which they lie. Strict adherence to failure analysis and reliability engineering assures applicable, effective PMs. System level availability and failure analysis would greatly benefit electric power stations. Risk ultimately translates into ‘operating events’ that impact equipment and employees. Direct costs include rework, increased scheduling, and increased risk. High risk organizations mean higher cost operations. Analyzing failures and costs confirms this intuitive knowledge – maintenance performance correlates with insurances claim losses. Insurers periodically inspect client facilities to assess their risk and help clients better manage that risk. In deregulated environment, there are wide variations in electricity costs, in part because some producers are more expensive, based on their plant outage profiles, while for others its routine maintenance practices. With the deregulation, in Nigeria electric power industry, competition will force the players to re-evaluate and improve processes that have been slow to change. Plants and equipment become uneconomic when they become unreliable. The content of reliability depends on the operating mission. As items age, age based modes failure probabilities gradually increase. Eventually failure increase. Managed carefully, the overall failure rate for equipment can be controlled. Maintenance addresses component failures and their causes. Identifying common failure modes is an intermediate step to selecting effective PM. In most programmers, vendor-prescribed tasks may not be adequate. From an analytical perspective-and when cost-effectiveness and managing risk are involved (e.g. reliability engineering)-statistical frequency-of failure information identifies dominant failures, the occurrence frequencies, and the risk they pose in each application, so that overall strategy can be turned to manage risk.

Many sources of information identify viable PM tasks and their associated failures. In addition to vendor operation and maintenance (O&M) guidance, there are:

(i) Standard (industry upper groups, professional societies);

(ii) Legal guidance (in regulated fields);

(iii) Insurance standards;
(iv) Shop practices;
(v) Basic failure study and analysis; and
(vi) Benchmark plant or equipment practices

Peer programmes, supplies processes and iterative, and published professional society papers provide a wealth of additional information. In some instances, company or plant licenses may identify additional specific requirements, particularly environment or risk management requirements. To develop a complete equipment perspective, needs review of all information sources and establish a relevant programme based upon plant operating schedule, maintenance capacity and policies. The plan must meet optimization goals, work simply and the supported by workers. Worker commitment is crucial to PM success. Successful plans are those developed by worker team, incorporating their ideas.

Effective, simple PM standards can address general classes of equipment (supported by generic industry performance information). Site –specific failure experience and unique worker insights [1].

CONCLUSION

Low value maintenance work is because of understanding of what things do and how they interact, hence what has been done before is often repeated. When failure causes are not detected, the defensible action is to fix things. Nigeria electric power industry maintenance organization ignores written instructions, or do not predict failures and plant needs. Maintenance is tradition-oriented. The unresolved questions point towards plant maintenance risk management. Unfortunately, the plants have no process to perform a root-cause assessment. With little documentary performed units problems. The basic risk administered scheduled maintenance programme could not deliver TDM or on-condition maintenance (OCM)/CDM. Conditional overhauls correct primary and secondary failures but do not exhaustively replace non-aging parts and components. This could be used in more traditional electric power station maintenance to manage costs. In the case of turbines and other large rotating machines, this could be based on grouping many multiple independent failure mode PM tasks and the extensive disassembly required for large machines. For turbines, many inspection tasks need to be performed based on time and risk. Some include [1]:

Instruments

(i) Penetration welding inspection;
(ii) Failed thermocouple replacement;
(iii) Failed pressure sensing line replacement;
(iv) Calibration; and
(v) Control connector inspections

Stages

(i) Blade deposit;
(ii) LP stage tie wrap inspections
(iii) Blade root tip crack inspection;
(iv) Bearing dimensional checks;
(v) Steam cut checks;
(vi) Across gasket
(vii) Along the split casings; and
(viii) At penetrations.

Effective overhauls require using both time-based and condition maintenance risk management. Manufactures recommend performing inspections on very overhaul. But experience shows that doubling these intervals will be suitable. This adjustment provides risk management, but also substantially reduce overhaul costs. Overhaul tasks can be tine-based or on-condition. For example, performance efficiency, loading behavior, and main bearing vibration-level trends are on –condition indications. Time-based age mechanisms include blade root tip cracks, tie wrap cracks, and control value deposits. Blade deposits can be monitored careful stage efficiency tests. That may necessitate instrumentation maintenance such as calibration. Overhaul timing can be improved using a combination of:

(i) Known ageing performance;
(ii) History since last overhaul;
(iii) Condition-monitoring as an ongoing risk control practice. The on-condition (Condition-directed tasks include);
(iv) Bearing temperatures (thermocouple replacement)
(v) Bearing vibration(bearing inspection and rework)
(vi) Performance (specific problem identification and correction like blade deposit and erosion)
(vii) Load capacity; and response
(viii) Control value position trends (value system and seat rework);
(ix) Value stroke tests (value packing and operators); and
(x) Turbine protection tests (protective devices rework)

The Nigeria electric power industry maintenance often lack specific information on when components and parts entered service. They also lack failure mode statistics-which modes are dominant, their likely causes, age dispersion at failure and related failure. Standardization can simplify maintenance failure analysis. Considerable equipment improvement can be achieved by using maintenance performance information to identify dominant failure modes and benchmark these to manufacturer standards and industry data, with specific failure resistance criteria, sample and project comparable equipment failure rates for similar environments. Specific failure resistance criteria are one implementation key. Applying similarity analysis to identify similar applications for specific failure modes of concern is another. These should reflect operating and environmental factors such as the plant, external operating factors service, and use. Techniques to form up and manage risk are to ensure an effective condition monitoring programme is in place. The use of condition monitoring, age exploration and other hedges can reduce the tendency to incrementally extend equipment inspection intervals. A database of equipment components and their failure modes is also helpful, as are benchmark intervals. A strategy of managing the known aging failure with on condition or time –based maintenance, as appropriate based certainty of aging and organizational capability, combined with condition monitoring, maintains the equipment very well. The challenge of Nigeria electric power industry is to develop simple standard applications of these strategies. However, it is argued that if proper consideration of risk management in maintenance decisions, the number of failure can be reduced and their consequences minimized considerably

REFERENCES

1. August, J. (1999 Applied Reliability Centered Maintenance, Penn Well, Tulsa, Oklahoma 74101
2. Markeset, T and Kumar, U.(2003). Integration of RAMS and Risk Analysis in Product Design and Development Work Processes, Journal of Quality Maintenance Engineering, Vol. 9 No. 4 pp 393-410
3. Carter, A.D.S. (1997), Mechanical Reliability and Design. Macmillan, Basingstoke)
4. Moubray, J. (1997). Reliability Centered Maintenance, 2nd Ed. Industrial Press.
5. Fulton, W. (2000) Win smith Weibull Probability Plotting Software, http:www weibllnews.com
6. Barringer, H. P. (1999) http:www.eibull Failure database ''http: //www.barringer 1.com
7. Barringer, H.P. (2001) Why you need Practical Reliability details to Define Life Cycle Costs, for your Product and Competitors Products, Barringer and Associates, Inc P.O.Box 3985, Humble TX 77247-398
8. Barringer, H.P. (2000), Monte Carlo Simulation-LCC Subsethttp://www.com. barringer 1.com/lcc