Guidelines to Understanding to estimate MTBF

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Abstract— To quantifying a reparable system or reliability we can use MTBF. It has been used for various decisions. MTBF is determining the reliability. For developing the MTBF model we can use Poisson distribution, Weibull model and Bayesian are the most popular approach. In this paper we are talking about complexities and misconceptions of MTBF and clarify in sequence what are the items and concerns that need to be consider in estimating MTBF.

I. INTRODUCTION

To every industries to operates at lower cost, bigger profit and continuously to meet customer satisfaction MTBF plays a big role. MTBF mainly implemented for to planned maintenance regime instead of unplanned maintenance or reactive maintenance regime. Reactive maintenance seen to be one of the factor contributes to high manufacturing cost. MTBF study can be used as a bottom line for further improvement that needs to be done and as a monitoring tool to monitor the success of the improvement implemented. MTBF can synchronization the maintenance time to avoid frequent shutdown especially in a single-stream process. In a single-stream process, every shutdown due to whatever reasons seen as a maintenance opportunity and it is necessary for maintenance personnel to know what are the value can be added to the losses. The definition of MTBF based on failures and assumptions, which need a proper interpretation and well, kept in record. Therefore, this study will clearly interpret all the related components in MTBF. It is the most common means of comparing reliabilities, the factor of meaningless MTBF results are unclear failure definitions, misinterpretation and unrealistic estimations. Field data measurement uses field failure data produces more accurate results than simulations. New design product or low volume productivity of product may not have sufficient field's data, thus field data measurement is more accurate.

II. DEFINITIONS

Availability is an ability of a component to be in state to perform a required function at a given instant of time or at any instant of time within a given to time interval, assuming that the external resources, if required, are provided.

Dependability is the ability to deliver service that can justifiably be trusted.

Reliability is an ability of a component to perform a required function under given conditions for a given time interval.

Fault is adjudge or hypothesized cause of a system malfunction.

Error is a deviation from the correct service state for a system or a subsystem.

Failure is a transition event that occurs when the delivered service deviates from the correct service state to an unwanted state.

Failure rate is the frequency with which an engineered system or component fails.

III. FAILURE AND ASSUMPTIONS

The definition of failure is actually infinite it is not limited to below two. Realistic assumptions have to be considered. To simplify the process of estimating MTBF assumption are required. It is almost impossible to collect the correct data and calculate the exact number. Assumptions may come from past experience, journals, hand book or proved previous similar project.

1) To perform its required function whole failure system is require.
2) Failure of any individual system (subsystem) to perform its required function but not to the system as a whole.

IV. ESTIMATION OF MTBF AND PREDICTION

MTBF and service life is two different things. Service life can expressed as expected number of operating hours before system fails. While MTBF describe as:

$$MTBF = MTTR + MTTF$$

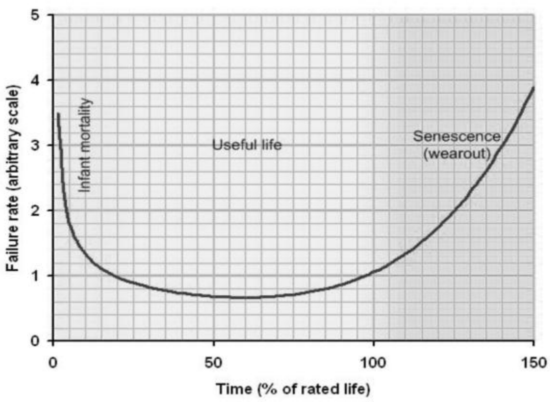

Fig. 1: Bathtub curve illustrate consistent rate of Failures

MTBF consist of mean time to repair (MTTR) and mean time to failure (MTTF). To focus at the right angle we have deep understanding of product behavior. While product still in their "useful life" or "normal life" will gives high MTBF as a result. It is because; at this period it's experiencing the lowest and almost a constant failure rate... There should be no coloration between MTBF and service life. A product can be extremely high MTBF (reliability) but a low service life. See Fig. 1.

Product is in use in useful life period the field with a product quality and results to a constant failure rate with respect of time. Source of failures at this stage could include:

1) Undetectable defects.
2) Low design safety factor.
3) Higher random stress than expected
4) Human factors.
5) Natural failures.

There are two ways to determine MTBF.

Reliability Prediction Method (Predict MTBF)

It is usually performed early in the product lifecycle and based on the system design values are calculated. For example; new product designs. If field data does exist, this method should not be use.

Reliability Estimation Method (Estimate MTBF)

The method is to calculate value based on observe sample of similar system. It could be done with large population of sample deployed in the field. It is most widely used as the product tested under a real working environment.

Determining MTBF by using estimate method is commonly use. MTBF is often confused with mean time to failure (MTTF), which applies to replaceable rather than repairable unit. The biggest challenge in implementation of Estimate MTFF is time. High reliability product will takes longer time. MTBF can be estimated in shorter time. Run the test with the population of units until long enough to have reasonably large number of failures. Replace the failed unit in the test population with a new unit. MTBF approximation can be obtained by multiplying number of units in the population by the total time, and dividing by the total failures. For the better approximation of actual MTBF larger number of failure are require.

For a repairable system, run a small number (as small as one) of units until they have experienced a number of failures (repair each failed unit and put it back into the test). Then take the total running time and divide by the number of failures. Formula for calculating the MTBF is (Scott Speaks, Vicor Reliability Engineering):

$$MTBF = \frac{\text{Total Time (T)}}{\text{Number of failures (R)}}$$

For calculating the MTTF is:

$$MTTF = \frac{\text{Total Time (T)}}{\text{Number of units under test (N)}}$$

V. LIMITATION OF MTBF AND MTFF

The main issue that deviate MTBF results is aging. Each component has its special age-related degradation mode. During repair Wear and tear effects at components are commonly detectable. Various effects, such as corrosion, slowly take their roll. As these phenomena goes on, unit will begin to fail at increasing rate where they have passed the useful lives. See Fig. 1.

For the success of the MTBF estimation realistic assumptions are always there. Annual failure rate (AFR), has two scenarios that need to be considered (American Power Conversion, White Paper #112, 2004). Scenario 1 makes the following 2 assumptions: (1) the products operate 24 hours a day, 365 days a year; (2) all the products in the populations begin at the same time. It is relevant for products that are continuously running. Scenario 2, for products is known to run intermittently.

VI. MTBF IMPROVEMENT

Jacob and Sreejith (2008) introduced minimum mean time between failures (MMTBF) that is another approach to improve MTBF. The improvement does not mean the improvement of MTBF results. It is the way of determining value of improvement that sufficiently needed. This mean MTBF will be further improve by two key components; a specified MMTBF and a maximum acceptable probability of premature failure, Pj. Pf is the probability that the time to failure smaller than MMTBF. This approach is to determine the value of reliability that need to be improve. The value can be decided based on the control chart. The control chart also can be used to monitor improvement in reliability for necessary action to be taken if the improved system is not reflecting the desired result. The control chart must have upper control limit (UCL), central limit (CL) and lower control limit (LCL). Assuming false alarm probability a.

VII. REDUCE REACTIVE (UNPLANNED) MAINTENANCE

To avoid costly and unnecessary breakdowns, or to keep process equipment running condition at target efficiently, In Plant Asset Management (PAM), there are three main characteristics to generate planned work in time:

1) Potential problems are identified before they effect the process;
2) The health of the plant assets is assessed using a combination of products and services; and,
3) Maintenance activity is driven by problem severity, potential causes, and operator options.

VIII. RESEARCH METHODOLOGY

Plant's MTBF Base Line
MTBF situations will use for improvements.

Type of Improvement
There are few types of improvement:

1) *Improvement on components MTBF by:*
   1) Improvement on component design
   2) Replace to high-reliable product
   3) System adjustment
2) *Sufficient number of spares Instrumentation:*

For complex engineering design improvement Finite Element Analysis (FEA) will be use.

1) Data Collection

Historical data for parts replacement or maintenance will be drill out from Maintenance register.

2) Limitation of Study

This study is limited to single streamed Titanium Dioxide manufacturing, which uses Sulfate process

IX. CONCLUSION

Reactive maintenance is one of the main pulling factors that limit the organization from being best-cost-producer. Its affect the organizations in many ways. Annual manufacturing cost, customer satisfaction and company's image are put into jeopardize if the organization's maintenance mode is not been shifted from reactive regime to predictive

REFERENCE

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[2] National Conference on Postgraduate Research (NCON-PGR) 2009 1st October 2009, UMP Conference Hall, Malaysia © Centre for Graduate Studies, University Malaysia Pahang Editors: M.M. Noor; M.M. Rahman and K. Kadirgama