

Minimizing Incident Stoppages on Critical Equipment by Inspections and Planning.

‘Damilare T. Onawoga, B.Sc.¹ and Olasunkanmi O. Akinyemi, M.Sc.²

¹Methods Department, Lafarge Cement (WAPCO) Nigeria, PMB 21011, Ikeja, Lagos, Nigeria.

²Department of Mechanical Engineering, Olabisi Onabanjo University, PMB 5026, Ifo Post Office, Nigeria.

E-mail: damilareonawoga@gmail.com¹
sukiyomakie@yahoo.com²

ABSTRACT

This work reveals how incident stoppages cut deeply into the production time of manufacturing industries with a respective loss in output and value. It explains how intense emphasis on the integration of adequate inspection policy with maintenance planning in Critical Machine Maintenance Management Program (CMMP) is a vital key to minimizing incident stoppages. With condition monitoring of variables (such as temperature, vibrations, noise, cracks), incident stoppages will be minimized with a subsequent boost in production output, value and plant's useful life.

(Keywords: incident stoppages, critical equipment, inspections, planning)

INTRODUCTION

Critical equipment include machines that are vital to a plant or process; they are a key part of a production process and are usually fully monitored to avoid failure. A critical machine is one in which all its processing time are part of its make-span [1]. A very good example is the kiln of a cement manufacturing plant [2]. A critical machine is the heart of any production plant equipment and being the heart of the process, it is seen to require full online condition monitoring to continually record as much data from the machine as possible regardless of cost and is often specified by the plant insurance [3].

Most manufacturing industries come up with production targets at every production phase; however, there is little knowledge to identify that these targets are subject to the critical equipment reliability and availability. If production targets are to be met or surpassed, great attention should be

drawn to how to minimize critical equipment stoppages by adequate inspections through plant online monitoring. Meanwhile few industries have been able to develop individual policies on how to tackle this challenge; but with the result of this work:

- i. Equipment breakdowns that cause a corresponding loss in productivity due to ineffectiveness will be reduced to the barest minimum.
- ii. Equipment life will probably increase as long as (i) above is achieved.
- iii. An appreciable output in the work system (i.e. Man – Machine system) will be produced.

CRITICAL EQUIPMENT STOPPAGES

Stoppages are in three different phases which are:

- (i) **Planned Stoppages:** Planned stoppages are calculated duration for which an item/machine has to be stopped. This is usually worked out in advance for special purposes such as maintenance or inspections.
- (ii) **Circumstantial Stoppages:** connotes stoppages that cannot be controlled or that are out of reach of the personnel especially stoppage cases that are due to nature. An example is a case of interrupted power supply to the plant.
- (iii) **Incident Stoppages:** is just the direct opposite of circumstantial stoppages; stoppages that can be avoided or minimized.

They are within the capacity of the personnel in charge.

Incident Stoppages are not to be encouraged in manufacturing industries this is why every attempt should be made by the maintenance engineer to minimize or possibly avoid incident stoppages.

CAUSES AND SOURCES OF FAILURE

The causes of failure are numerous, however, the major ones according to Mechefske [4] include:

- a) Design deficiencies
- b) Material deficiencies
- c) Processing deficiencies
- d) Improper assembly practices
- e) Improper service conditions
- f) Inappropriate maintenance
- g) Excessive demands

Aside from the causes of failure, there are also sources of failure which are majorly categorized as the 4Ms:

- (i) Man
- (ii) Methods
- (iii) Materials,
- (iv) Machine

Man as a failure source can occur from lack of training/experience, human error or poor supervision. *Machine* failure source can occur from poor maintenance, equipment used beyond its design criteria, or machinery that is old and/or outdated. *Methods* can also be a failure source and can occur from lack of supervision and this is where Inspections have to be infused.

THE EFFECT OF PLANT DOWNTIME ON REVENUE

Burbidge [5] described different types of capacity as shown in Figure 1 below. It can be seen from the illustration that in planning for available productive capacity of a plant, some element of downtime is taken into account. Over and above this downtime will result in loss of production and with the corresponding loss in revenue. If downtime therefore can be minimized and thereby increasing facility availability, the company stands to improve upon output and revenue, reduce production cost, thus improving profit.

Maximum productive capacity – 168hours/ week				
Productive Capacity on normal time		Planned Overtime		Not worked
Planned Productive Capacity				
Available productive time	Idle plant time	Plant ancillary time	Plant Down-time	

Figure 1: How Available Productive Capacity is Made Use Of.

(Note: Figure 1 is not drawn to scale, the idle plant time, plant ancillary time and downtime will vary from one company to the other. The planned productive capacity for example will depend on the number of shifts).

The effect of change in output on the profit contribution can also be illustrated by oversimplified form of break-even chart shown in Figure 2.

For this analysis, the revenue and cost lines have been shown as straight lines when in reality they are normally curves. Literatures on economics give a more complete explanation of marginal cost analysis. With reference to Figure 2, the planned level of activity taking into account planned downtime is P_1 . As the company improves upon plant availability, output can be increased to quantity assuming that production capacity is the limiting factor; revenue can therefore be earned at a higher rate.

If however, due to absence of an effective maintenance system the downtime increases more than what has been planned, the level of

activity will drop to P_3 . This will result in loss of some of the budgeted profit. Increase in plant downtime also means increase in volume of maintenance tasks to be undertaken. This increases the overall budgeted maintenance costs and therefore further reduces the budgeted profit.

METHODOLOGY

To effectively tackle incident stoppages, two key factors must be integrated; these include:

1. An Inspection based effective Equipment Maintenance Strategy for Critical Equipment; and
2. A Critical Machine Maintenance Management Program (CMMP).

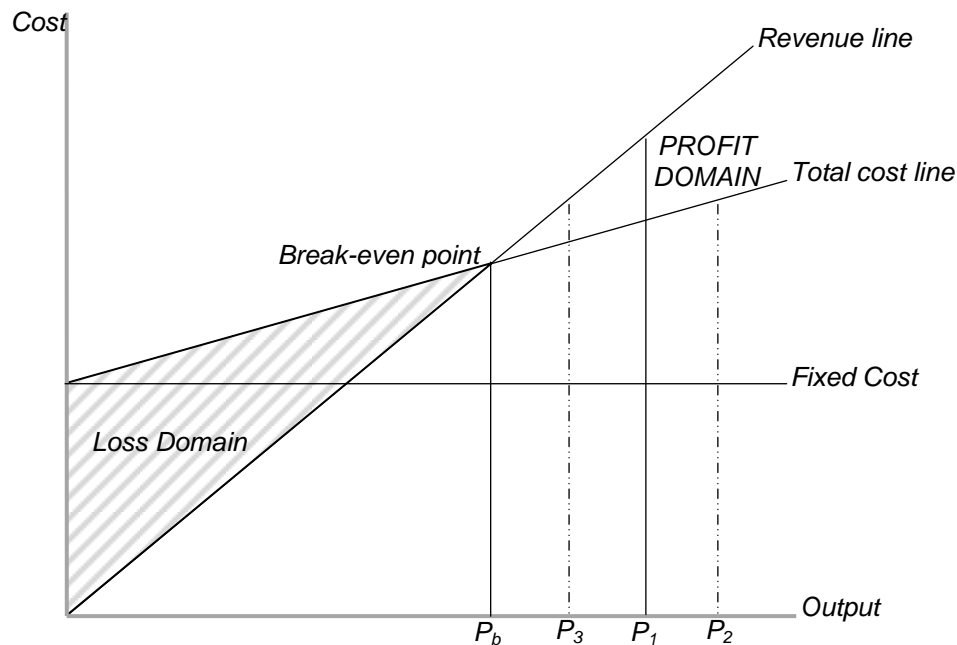


Figure 2: A Break-Even Chart Showing Various Levels of Plant Activities as a Result of Improving Plant Availability.

(Note: Total cost = Fixed cost + variable cost since all semi-variable cost can be segregated into fixed and variable components, then all the costs in a company can be analyzed into fixed and variable categories. P_b is the level of output to break-even; that is Total Cost = Revenue)

INTEGRATING INSPECTION TO EQUIPMENT MAINTENANCE STRATEGY

Minimizing Incident stoppages start by adopting an effective maintenance strategy. Onawoga and Akinyemi [6] in their paper; "Development of Equipment Maintenance Strategy for Critical Equipment" integrated six basic factors influencing maintenance strategic developments, which are Inspection, Planning, Scheduling, Execution, Improvement and Management. It was stated that these six key functions will form the foundation and backbone of any worthy maintenance strategy to be developed that will be universal and generally accepted for use in any manufacturing outfit. However, it will suffice to mention that Inspection plays a key function in a worthwhile maintenance strategy because it seeks to monitor failure modes and analyze them by following trends with a key view to minimize stoppages.

INSPECTION(S) IN MAINTENANCE ACTIVITIES

Maintenance activities in developed manufacturing industries have really given inspections top priorities because of the benefits thereof such as:

- a) To ensure the useful life span of an item,
- b) To increase availability of installed equipment,
- c) To ensure operational readiness of all equipment required for production,
- d) To ensure the safety of people (personnel) using such equipment,
- e) To avoid exorbitant expenses on repair of equipment which might occur if the same equipment was not maintained and is allowed to fail.

Inspections form the backbone and foundation of every maintenance action because a worthwhile maintenance team integrates the benefits of maintenance to be able to forestall equipment/ machinery unavailability possibilities.

Literarily, Inspection means a critical examination of something; aimed at forming a judgment or evaluation.

Plant Inspections aim at maintaining in-depth knowledge of the condition of all equipment on a continuous basis.

Inspections are of two types according to the resources involved; these are:

- i. First Level
- ii. Specific Inspections

First Level Inspections are inspections that do not require any tools and with which values and measurements are not required. This type of inspection simply requires the aid of the four human senses which are Sight, Touch/ Feel, Smell and Hearing. First level Inspections are basically pro-active maintenance strategies means to forecast breakdowns. Usually, first level inspections are used:

- a) To detect abnormal conditions and operating anomalies such as *overheating, excessive vibrations, leaks, wears and tears, expansions, etc*
- b) To check operating parameters

Specific Inspections require special tools and with which values and measurements are required. Specific Inspections measures specific operating parameters of item especially endoscopic parameters such as internal cracks of gear teeth to analyze conditions. The idea behind this is to follow trends of taken and recorded parameters, forecasting anomalies and making recommendations where necessary.

WHY FOLLOW TRENDS?

Moving machinery has thresholds before breakdowns; this explains the reason why such machinery so critical to plant operations should not be allowed to get to a point of failure and this can only be done by effective online monitoring, taking measurements and usually comparing

them to standards. Following trends is an attempt to compare measurements taken with acceptable reference values so as to know when the equipment parameter level is still allowable or when it reaches and alarm level or when an action value is reached.

For example, below is a table on temperature reference values for some equipment as listed.

DEVELOPING A CRITICAL MACHINE MAINTENANCE MANAGEMENT PROGRAM (CMMP)

A Critical Machine Maintenance Management Program (CMMP) is a maintenance tool; the International Standards Organization (ISO) defines it as a field of technical activity in which selected physical parameters, associated with machinery operation, are observed for the purpose of determining machinery integrity; it is not just vibration based [4].

A major aim behind employing a CMMP is to minimize stoppages on running equipment by providing quantitative information on the present condition of the machinery that will aid in planning maintenance. Reasonable expectation of

machine performance is the headache of maintenance engineers and with the CMMP; he will be able to make certain correlations such as:

- If a machine will stand a required overload,
- If an equipment should be serviced now or later,
- The expected time to failure,
- The expected failure mode.

CONCLUSION

Inspections and Planning form the basis of any worthwhile maintenance activity, aimed at minimizing stoppages and increasing revenues and this why they should be given top priority. With effective inspections and planning, there will be:

- i. Increased Unit Availability
- ii. Increased Work Productivity
- iii. Decreased Maintenance Frustrations

Table 1: Table Showing Temperature Reference Values for Some Equipment as Listed.

COMPONENT	ORIGINAL VALUE	ALARM VALUE	ACTION VALUE
Gearbox	Taken during commissioning.	70°C 40°C above ambient temperature	90°C 60°C above ambient temperature
White metal bearing and Brass bearing	If not available, taken in the manuals.	60°C 5°C above normal operating conditions	80°C 15°C above normal operating conditions
Rolling elements bearing with grease application	If not available, compare with similar equipment	80°C	90°C
Rolling elements bearing with oil application	If not available, formal request to experts, Technical Centre	90°C	105°C

REFERENCES

1. Anders, S. 2003. "Management Aspects on Condition Based Maintenance – The New Opportunity for Maritime Industry". Paper presented at the 9TH International Conference on Marine Engineering Systems at the Helsinki University of Technology (HUT) Ship Laboratory and on board MS SILJA SERENADE.
2. Lafarge, WAPCO. 2008. *Cement Professional Handbook*. Industrial Training Department, Lafarge Group, Nigeria.
3. Peltz, E., L.P. Colabella, B. Williams, and P. Boren 2004. *The Effects of Equipment Age on Mission-Critical Failure Rates – A study of M1 Tanks; Maintenance and Repair*. Prepared for the United States Army; RAND, Arroyo Center.
4. Mechefske, C.K. 2006. *Machine Condition Monitoring and Fault Diagnostics*. Mechanical Engineering Department, Queen's University.
5. Burbidge, J.L. 2003. *The Principles of Production Control*. Mac Donald Evans Ltd.: London, UK.
6. Onawoga, D.T. and O.O. Akinyemi. 2010. "Development of Equipment Maintenance Strategy for Critical Equipment". *Pacific Journal of Science and Technology*. 11(1):328-342.

ABOUT THE AUTHORS

Onawoga 'Damilare Temitope graduated from Olabisi Onabanjo University, Ago Iwoye, Ogun State, Nigeria with a B.Sc. degree in Mechanical Engineering. He is currently a Mechanical Inspector in Methods Department of Lafarge Cement; WAPCO Nigeria (LAKATABU Plant). His research interests include Maintenance Engineering, Systems Engineering and Local Substitutions.

Akinyemi Olasunkanmi Oriola graduated from the University of Ibadan with a M.Sc. degree in Industrial and Production Engineering. He is currently a Lecturer in Mechanical Engineering Department, Faculty of Engineering, Olabisi Onabanjo University, Ago Iwoye, Nigeria. His research interests include Systems Engineering, Corrosion Engineering, Welding and Local Substitutions.

SUGGESTED CITATION

Onawoga, D.T. and O.O. Akinyemi. 2013. "Minimizing Incident Stoppages on Critical Equipment by Inspections and Planning". *Pacific Journal of Science and Technology*. 14(1):240-245.

 [Pacific Journal of Science and Technology](http://www.akamaiuniversity.us/PJST.htm)