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# OPTIMIZING ROTATING EQUIPMENT MAINTENANCE MANAGEMENT IN NIGERIAN REFINERIES

By

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## ABSTRACT

Maintenance issues in the Nigerian refineries have often resulted in Nigeria having to depend heavily on importation of finished petroleum products. Rotating equipment maintenance practices are investigated, with shortcomings in the implementation of current maintenance procedures identified. The research adopted a case study of four refineries and employed the use of questionnaires, interviews and observation technique to gather relevant data. From research findings, a procedure to Manage Rotating Equipment Maintenance Strategy was developed based on reliability-centered maintenance principle of condition based maintenance. The procedure consists of four sub processes. In addition, a new Internal Job Card and a Framework and Approach for Training and People Development were developed for the rotating equipment maintenance departments of the Nigerian refineries.

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## INTRODUCTION

Lack of mandatory turn around maintenance (TAM) every two years and poor management has made all the refineries inefficient, thereby operating at about forty percent of full capacity, at the best of times (*Alexander Oil & Gas, 2004*).

Rotating equipment, which makes up the large contingent of refinery hardware (numerically), is particularly susceptible to component wear, and, consequently, constitutes some of the more

important issues in the refining sector (*CITGO, 2008*).

Even with the huge investments on turn around maintenance, the refineries are still in a state of disrepair (*E. E Okafor, 2007*). Afonja (*2003*) and Kupolokun (*2005*) also described the Nigerian refineries as ‘problematic’.

The broader intent of this research is to investigate the causes of rotating equipment

failure in Nigerian refineries and provide a procedure to manage equipment maintenance strategy, and also develop a new internal job card amongst other recommendations, as a positive step in addressing low availability of rotating equipment.

### **PROBLEM STATEMENT**

Maintenance problems have resulted in low availability of rotating equipment in the Nigerian refineries thereby forcing the country having to depend heavily on importation of finished petroleum products, and necessitating the investigation of its existing maintenance management practices.

### **METHODOLOGY**

The research evolved around a case study of four (4) petrochemical refineries with a critical focus on the Nigerian refineries. Methods employed to assemble data also include; the use of questionnaires; and interviews.

### **FINDINGS AND DISCUSSIONS**

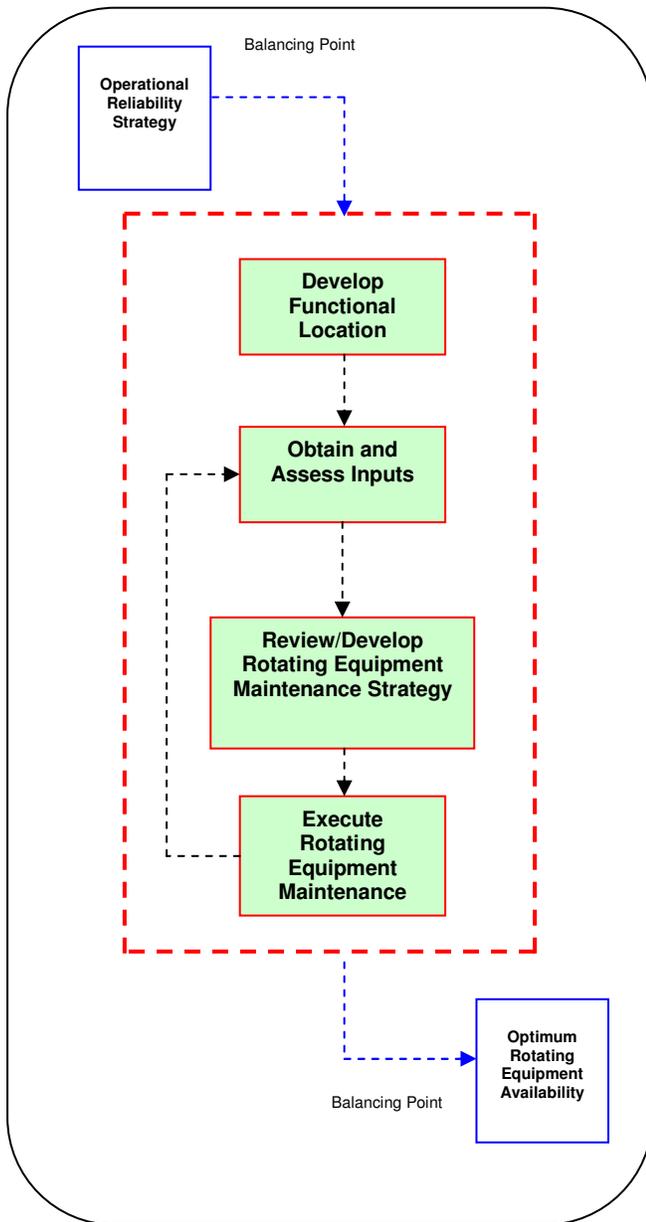
From interviews, rotating equipment maintenance personnel in the Nigerian refineries acknowledge that quite a few maintenance activities takes place outside scheduled turnaround maintenance. This has often led to unplanned shutdowns of rotating equipment. It was further discovered that corrective maintenance actions often takes place, skill and competence of mechanics is low, analytical ability for root cause analysis is inadequate. Furthermore, there is no adequate computer support for maintenance management.

From questionnaires, seventy-three percent agreed that scheduled maintenance has been adopted for rotating equipment. Twenty-seven percent says a lot of corrective actions take place also as most maintenance tasks are scheduled for TAM and that these schedules decision negatively affects the availability of rotating equipment. Fifty-four percents says a success rate of seventy-five percent has been achieved in analyzing equipment failures. Thirty-two percent said root cause analysis often stops at identifying direct causes of an undesired outcome. Fourteen percent disagreed totally by saying the analysis process is haphazard. All respondents are not satisfied with job card and also the fact that only operating departments can request work. Also, respondents agreed that the introduction of condition-based monitoring application for rotating equipment would complement maintenance program and boost rotating equipment availability.

The correlation of research instruments showed major maintenance management lapses relating to rotating equipment and maintenance personnel.

### **THE MANAGE ROTATING EQUIPMENT MAINTENANCE STRATEGY PROCEDURE**

The Manage Rotating Equipment Maintenance Strategy (MREMS) procedure consists of four (4) main sub-processes as shown in figure 1. These processes include; develop functional location structure; obtain and access inputs; review/develop rotating equipment maintenance strategy; and execute rotating equipment maintenance strategy.



**Figure 1 – MREMS Block Diagram**

Developing functional location structure involves setting in place a functional hierarchical representation of the rotating equipment on the plant. It is essential for managing costs or reliability reporting and for managing schedules in the Computerized Maintenance Management System (CMMS).

Obtain and assess inputs involves data and information assembling required to reviewing or

developing the rotating equipment maintenance strategy.

The feedback loop consists of performance measurements obtainable from rotating equipment maintenance personnel or the Computerized Maintenance Management System (CMMS). A job card that would also facilitate appropriate feedbacks is presented below. This step will be initiated by any event that causes the review or development of a new rotating equipment maintenance strategy. It can also be facilitated by periodic reviews as well as unpredicted rotating equipment failure.

The review or development of the rotating equipment maintenance strategy will be executed by adopting a selective approach. This involves identifying rotating equipment based on criticality. The review or development of a specific rotating equipment maintenance strategy will be based on the answers provided for by the Failure, Mode, Effect and Analysis study.

Execution of the rotating equipment maintenance strategy will involve job grouping and schedule loading into the Computerized Maintenance Management System (CMMS). Job grouping will involve the classification and assembling of all rotating equipment maintenance tasks that can be executed together at the same period. This is compiled as a task sheet the rotating equipment maintenance mechanic will be required to complete at specified times.

### **INTERNAL JOB CARD**

An Internal Job Card was developed for the rotating equipment maintenance departments of the Nigerian refineries. This is shown in figure 2.

The new Internal Job Card would assist in the better management of rotating equipment in the Nigerian refineries and also commit maintenance personnel to assume responsibilities in an effective way. The Internal Job Card will further ensure that maintenance backlogs are easily monitored.

Company Internal Jobcard

Functional	Description
Equipment No:	Equipment Type
Technical ID:	

Main Description of Work Order

Maintenance Plant:	Priority:	Required Date:
Work Order No:	Date:	Created By:
Main Work Centre:	Description:	
Notification No:	Date:	Created By:
Planner Group:	Tel. No.	
Originator:	Originator Tel:	

OPERATION TASK INSTRUCTIONS

Operation Number	Perform Work Centre	Scheduled Start Date	Scheduled End Date	Scheduled End Time	Scheduled Hours	Quantity

MECHANIC TASK FEEDBACK (Hours)

Mechanic Name	Mechanic ID. No.	Actual Start Date	Actual Start Time	Actual End Date	Actual End Time	Actual Hours	Quantity

MECHANIC EQUIPMENT FEEDBACK (Record)

Object Part	
Damage	
Cause	
Activity	

MECHANIC LOST TIME FEEDBACK (Hours Lost)

Mechanic ID. No.	Lost Time	Lost Time Reason

**CONFIRMATION OF WORK PERFORMED**  
 I hereby certify that to the best of my knowledge, this work has been performed in accordance with Company codes and regulations.

Supervisor name: ..... ID. No. .... Signature: ..... Date: .....

Figure 2 – Internal Job Card

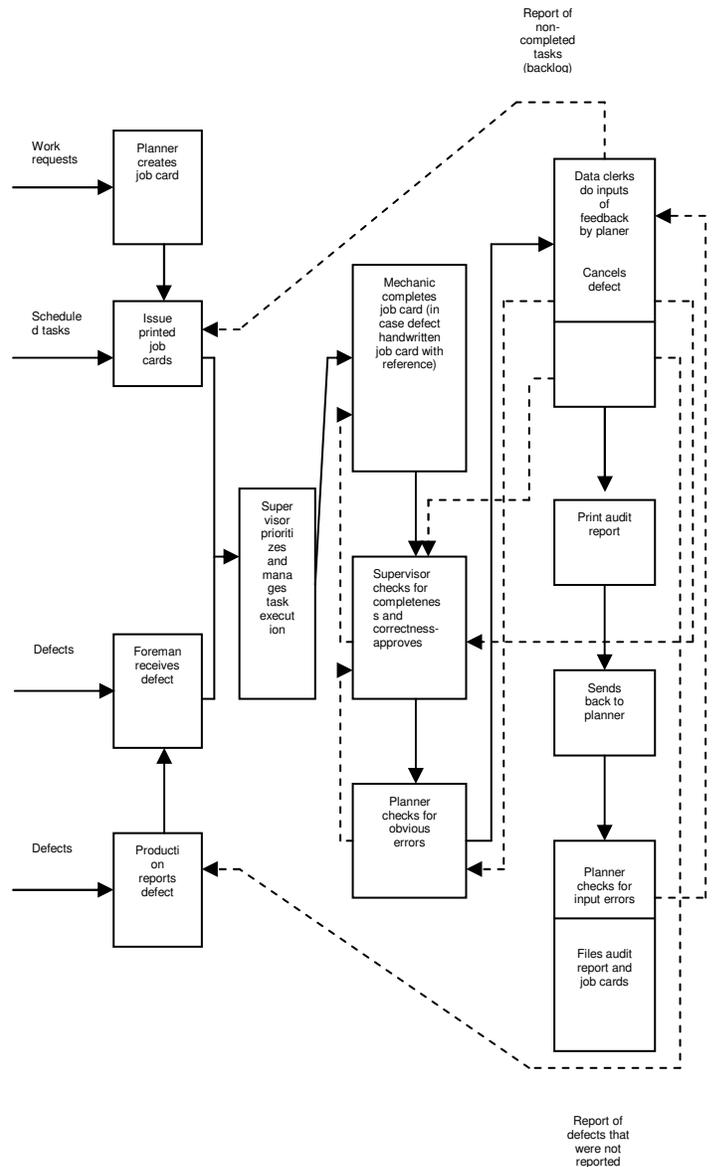


Figure 3 – Internal Job Card Flow

Figure 2 highlights the ‘Functional Location’, ‘Description’, ‘Equipment Number’, and ‘Technical Identity’ of the rotating equipment. This serves to establish a unique description, distinction and location of the rotating equipment. The ‘Main Description of Work Order’ serves to ensure that work is categorized based on criticality or equipment requirements. ‘Maintenance Plant’, ‘Work Order Number’, ‘Main Work Centre’,

‘Defect Notification Number’, and ‘Originator’ highlights the flow or development path of the Internal Job Card. It would also provide a base for maintenance audit. ‘Operation Task Instruction’ serves to provide adequate information concerning the task(s) to be performed. ‘Mechanic Task Feedback’ and ‘Mechanic Lost Time Feedback’ is expected to introduce accountability and measure personnel core job skill and performance. ‘Mechanic Equipment Feedback’ would aid the development of proper equipment record and also contribute to feedbacks and inputs required to review or develop strategy in the MREMS procedure.

Figure 3 is a recommendation of a descriptive job card flow chart that can be adopted by the rotating equipment maintenance department of the Nigerian refineries. *(This is as derived and modified from ‘Maintenance’, Compiled by Coetzee J. L, 1997:357)*

## **FRAMEWORK AND APPROACH FOR TRAINING AND PEOPLE DEVELOPMENT**

A model Framework and Approach for Training and People Development (FATPD) for the Nigerian refineries was proposed based on research findings. In developing the model FATPD, the identification of rotating equipment types and core skill requirements for important tasks in the rotating equipment maintenance departments of the Nigerian refineries became essential.

The training framework consists of training or learning areas that rotating equipment maintenance personnel are required to build progressive skills and competence. The training

frame work is subdivided into three (3) sections; general skills; general skills for rotating equipment mechanic; Disassembling and assembling of rotating equipment.

Based on the findings of the research, healthy training and people development vision proves to have a positive impact on rotating equipment maintenance management in one of the case studies environment. The potential viability of the FATPD was also validated by comparing it with the existing training plan in this case study environment.

The Framework and Approach for Training and People Development (FATPD) highlighted above will provide a platform for the rotating equipment maintenance department to also evolve there own, more specific, training and development plan.

## **RECOMMENDATIONS**

Recommendations on the procedure for MREMS are as follows:

- A “Responsible, Accountable, Consult and Inform” (RACI) structure would ensure that the procedure is not abandoned mid-way implementation.

Recommendations on the proposed internal job card are highlighted as follows:

- The internal job card should be well explained to all maintenance personnel. A commitment for adherence should be obtained as this is essential for feedbacks into the computerized maintenance management system (CMMS).

- Operation task instructions should be properly outlined on the Internal Job Card.
- Rotating equipment mechanic should provide three (3) comprehensive feedbacks on; task; rotating equipment; and lost time if applicable.
- Lost time should be investigated and dealt with appropriately.
- These feedbacks should be stored in a computer database.
- All job cards must be signed on or off when required.

The following recommendations will support the implementation of the FATPD:

- Training needs of individual personnel should be identified. An assessment on core job skill will be proper. The objective of the assessment should be explained to the personnel.
- Management should ensure that personnel develop skill and competence where it is identified as required. Management flexibility with time will be an important factor here.
- Management commitment to training and people development should reflect on budgets.

Other recommendation includes:

- Adoption and implementation of computerized maintenance management system (CMMS).
- Condition monitoring should be assimilated into the preventive maintenance program of the rotating equipment maintenance department of the Nigerian refineries.

- Most importantly, accountability and transparency should be promoted within the system.

## CONCLUSION

One of the objectives of the Sasol plant was to move from a ‘run-to-failure’ maintenance philosophy to a predictive maintenance strategy. “That goal has apparently been met. Helson said that \$1.66 million in savings for Sasol came through the avoidance of three plant shutdowns that would have been unplanned” (*Wes Iversen, Automation World*).

The research findings sufficiently presented evidence to prove that three (3) key elements are vital to optimizing rotating equipment maintenance management in the Nigerian refineries; a procedure to Manage Rotating Equipment Maintenance Strategy (MREMS); the new Internal Job Card; Training and development (Framework and Approach for Training and People Development).

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