DESIGN OF A MAINTENANCE PLAN CENTERED ON RELIABILITY: AN INDUSTRIAL APLICATION

DISEÑO DE UN PLAN DE MANTENIMIENTO CENTRADO EN CONFIABILIDAD: UNA APLICACIÓN INDUSTRIAL

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Abstract: This paper presents the application of the methodology proposed for the development of maintenance programs based on reliability, where the criticality, functionality and the failure patterns for automatization systems are considered, as well as the consequences of the operation of the process, allowing the determination of possible mechanisms of prevention through the use of systems of detection of incipient failure, generating an warning in the presence of incipient failure and its effects**.**

Resumen: Este artículo presenta la aplicación de una metodología para el desarrollo de programas de mantenimiento basados en confiabilidad, donde la criticidad, la funcionalidad y los patrones de fallas de los sistemas de automatización son considerados, así como las consecuencias en las operaciones del proceso, permitiendo así la determinación de posibles mecanismos de prevención por medio del uso de sistemas de detección incipiente de fallas, generando advertencias por la presencia de las mismas y de sus efectos.

Keywords: Reliability, Preventive maintenance-based-condition, Median time to failure, Least squares analysis, Statistical control graphics.

1. INTRODUCTION

This work presents the application of the methodology proposed for the development of maintenance programs based on reliability, where the criticality, functionality and the failure patterns for automatization systems are considered, as well as the consequences of the operation of the process, allowing the determination of possible mechanisms of prevention through the use of systems of detection of incipient failure, generating an warning in the presence of incipient failure and its effects**.**

2. METHODOLOGY

The formulation of a maintenance program based on reliability requires concentrating the efforts and resources on the vital equipment, assigning priorities in function of determinant criterion that reflects the failure impact and the optimization of maintenance resources; the applied criterions are: Failure Consequences, Operational Flexibility, Impact in security and safe environment, Reliability and Repair Costs.

These criterions represent qualitative features of a system or equipment that afterwards should be transformed into quantitative features for their respective objective evaluation.

This consideration of the evaluation allows the objective selection of the equipments that require the application of the (RCM) methodology. Considering that all maintenance programs have the purpose of providing the safest operation of plants and processes, we proceed to define clearly the properties and functional features of operation, determining the operative capacity of its elements or instruments comparing the established conditions of design and the real conditions.

For that to happen the following should be carried out: the inspection of the facilities, consulting and interviews to the maintenance and operations personnel, revision of the manuals of operation of the plant, maintenance manuals, manufacturer manuals, inventory of the plant, plant diagrams and instruments, schematic planes of control and the narratives of used control routines.

Through the gathered information the Input-Output-Process (IOP) diagrams are generated by the means of the hierarchies or identified systems in the evaluation. Additionally functional diagrams should be represented in which some relationships are established between diverse functions, reducing this way the global function of the system to a processes of less complexity, in such a way that all those elements or necessary devices are included to go through specific functions.

Once defined and identified the complexity of the process, it is necessary to determine the vulnerability of the system, identifying possible failure, that is to say, to know the mechanisms of the failure of its elements or equipments and systems, as well as the individual mechanism of failure of its components.

To achieve this it is necessary to analyze the historic registered failures data, classifying and categorizing them, besides that, determining the effects that each individual fail produces in the operation of the system.

In this stage two techniques should be applied: a deductive one (failure tree) establishing succession of events, singular and multiple, referred to the fail which lead to the repercussion of a final effect given in particular; the other technique is a systematic procedure that describes the system's behavior after failures that have happened and even singular ones, going from the particular to the general aspect (FMEA).

Finally, we proceed to the selection of the maintenance tasks through a selection flowchart based on the classification of the effects caused by the presence of failures, which are represented by the hidden failures, security, and environment, operational and not operational. The mechanism and the failure consequences involved in the analysis are what determine the possible type of maintenance and the frequency with which the task should be performed.

3. DETERMINATION OF THE FAILURE MECHANISM

One of the challenges that face all industrial organization is determining the availability of their plants or equipments due to the necessity and importance of obtaining the maximum profitability from them. Now, the inherent uncertainty of failure in all processes or equipment is an important factor to be considered in the formulation of all maintenance programs. That is the reason why efforts should be concentrated on applying an evaluation to the registration process of failures reported in the equipments, determining the frequency of appearance by instrument families.

Through a technical analysis of the occurred failures, the statistical parameters are defined of the failure pattern with the purpose of obtaining reliability estimates, allowing to predict the most probable expected period for the appearance of failures and to achieve the prospective intervention of the preventive maintenance. The pattern formulated by the method of least squares, in whose parameters we estimate from the available data or frequency of failures that have occurred, this allows estimating the probability that an abnormal functionality event occurs, starting from these historical data. For the determination of the equation, the instrument families with the biggest incidence of failures registered in a period of time is selected and the parameter of reliability is determined *Median Time To Fail*. (MTTF).

4. SELECTION OF MAINTENANCE TASKS

For this phase the information recollected from the failures mode and effects analysis and the task selection algorithms of the RCM are used. This algorithms evaluates the consequences or failure impact and considers the particular features of each class of individual failure to assign a type of task of feasible maintenance that eliminates or minimizes the originated consequences. The tasks that are selected this way are the preventive type based on time and condition, this is because the equipments have high criticality and that is why corrective maintenance is not assumed. Concerning the type of procedure or maintenance action to apply, they arise from the particularity of the type of failure and of the revision of the maintenance protocols, as well as the manufacturer's manuals

5. FAILURE DETECTION AND DIAGNOSE

The failure detection and diagnose arises as a consequence of the necessity that requires the maintenance program of the equipments for the application of preventive maintenance tasks based on condition. The proposed system consists on establishing a redundancy arrangement in the capture of certain variables of the process reflected by the control and protection transmitters, this signals are compared allowing this way to detect deviations which are evaluated through the analysis of quality statistical control or control charts, determining the presence of special causes associated with incipient failures.

Through the applications of monitoring of plants, and by means of a continuous storage and processing of data from the process, the tendency charts or the series charts are carried out for each transmitter selected considering them in their operational context, that is to say, representing the operational behavior of the equipment. The main interest is to associate or to relate general events of operational behavior of the equipments, and its registering action of each one of the transmitter instruments, allowing then to generate the diagrams or control graphics which determine if the variability of the transmission corresponds with some abnormality or incipient failure in the process, when exhibiting a non Gaussian pattern.

6. CONCLUSIONS

The application of the RCM analysis to the industrial equipment reflects through the reliability indicators, a tendency in the decrease of functional failures. These evaluations associated with the costs benefits criterion indicate that the application of this type of methodology, are necessary to achieve levels of productivity, security and quality in industrial processes. The estimate analyses of the period between failures allow determining an equation to synthesize the optimum frequency of preventive maintenance intervention. The criterion of selection of the best period of intervention should be based on the average behavior of the MTTF defined in each monthly period during the evaluation time for any kind of instrument with the highest rate of failures.

An observation that arises from the deduction of the failure record is the necessity of a Failure Detection System (FDS) that allows the processing of the data in what refers to identification and that clearly defines what constitutes a failure of the equipment / instrument, as well as to differentiate the nature of them.

Concerning the proposal for the application of quality statistical control as an analysis tool for the evaluation of the operative behavior of the equipment, through the functional verification of the control instrumentation of control and safety systems, this represents a practical opportunity of application to conform the maintenance tasks based on condition.

In reference to the configuration of the comparison of control and shut-down signals from the same process variable, this application is of special importance because since the shutdown transmitters present features of hidden failures, this is a valuable opportunity for the elimination of the consequences or effects generated by functional failures (false alarms or omission of emergency situations

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