A PRELIMINARY STUDY ON THE MAINTENANCE STRATEGIES BASED ON RISK EVALUATION

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Abstract

Appropriate maintenance action can reduce maintenance expenses and improve maintenance benefits substantially. After introducing the definition and characteristics of risk-based maintenance (RBM), the authors describe the process of risk evaluation of equipment and put forward the maintenance strategies based on risk evaluation.

Keywords : maintenance management, risk-based maintenance, risk evaluation.

1 Introduction

Maintenance actions of equipment is the foundation of army combats, trains and combat readiness, so it plays an important role on the remaining, recovery and enhancing of battle effectiveness. Appropriate maintenance actions and scientific maintenance strategies can cut down maintenance expense substantially and improve maintenance benefits. Military great power in the world has constantly been exploring the maintenance strategies and methodologies, and the technologies and concept of the maintenance strategies have been greatly improved. Risk-based Maintenance (RBM), as a maintenance strategy, has been successfully used by commercial manufactures in the maintenance of large equipment.

2 The Definition and Characteristics of Risk-based Maintenance

Risk-based Maintenance (RBM) refers to a maintenance strategy on the basis of Cost Effective Maintenance (CEM) designed to optimize the equipment maintenance management by semi-quantifying risk evaluation on equipment systems.

And where, semi-quantification is defined as the simple and coarse quantification of the qualitative description of alternatives by ranking (discontinuous, imprecise). Semi-quantification risk-based evaluation is a methodology used to measure the discretion of risk by multiplying the endanger level caused by assumed faults (semi-quantification) by the possibility of malfunction (semi-quantification). The risk values are calculated by the following formula:

Risk Values =the endangered degree(S)×Occurrence(O)×Detection degree(D)

From the above definition and formula, we can describe the characteristics of risk-based maintenance:

(1) Realize the roles of maintenance fully. As same to RCM, RBM holds that predictive maintenance can not naturally result in highly reliability, which stress that the maintenance actions should be focused on the necessary maintenance activities instead of the traditional practice of having the equipment overhauled, which can cut down the item of preventive maintenance, man-hour and expenses.

(2) Identify maintenance action mode properly. The maintenance action is established on the basis of reliability characteristic and failure consequence and the implementation of maintenance action is in the light of the rule of applicability and validity of the maintenance activities, which could maximize the benefits and is bound of the way of timing overhauling.

(3) Determine the appropriate maintenance period. The local data, test results and the reliability statistics data ensure the most appropriate maintenance period can be obtained.

(4)Cut down the life-span maintenance period expense. RBM could identify the maintenance of each piece of equipment and risk of it, which can decrease the unnecessary inspection and repair, so it not only make it possible for the maintenance staff to focus their attention and resource on the most significant maintenance activities but also eventually reduce the cost of life-span maintenance expense of the equipment and thus realize the maximum benefit.

3 Risk evaluation of the weapons and equipment

As the key task of risk-based maintenance, the process of risk evaluation of the equipment is shown by Fig.1:

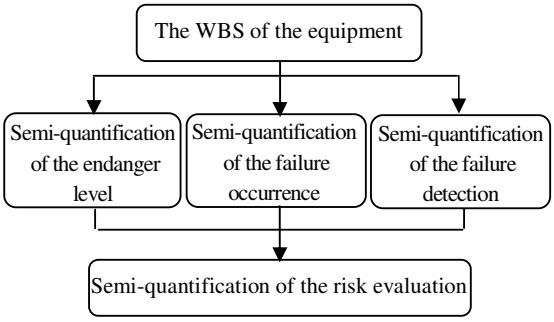

Fig.1 the main process of the risk evaluation of equipment

3.1 Work Breakdown Structure (WBS) of weapons and equipment

The objective of work breakdown structure of weapons and equipment is to find the component effect on the system and the tactical and technical index, and further analyze some built-in

redundancies of the system, which help to understand the station and function of a certain subcomponent in the whole weapons and equipment system. The work breakdown structure of weapons and equipment should be performed by scheduled procedure, that is, it begins with the main system and ends with each single equipment or subcomponent. The details of the procedure are referred in the work breakdown structure of weapons and equipment in GJB2116-1994.

3.2 Semi-quantification of endanger degree

According to the definition of semi-quantification, the ranking of the risk levels should be identified by four aspects: the quality of repair (the tactical and technical performance after repair), maintenance expense, maintenance time in length and security. For example, the maintenance expense could be ranked by three levels: in excess of 1 million, between 0.3 and 1 million and below 0.3 million. The maintenance time limit for a project also can be ranked by three levels in the same way: in excess of 10 days, between 3 and 10 days and below 3 days.

According to the chart of work breakdown structure, a certain equipment system is identified high-risk system or low-risk system. As for the high-risk system, semi-quantification risk evaluation is performed, and for the low one it becomes unnecessary, which can greatly cut down the inconsequential details of risk evaluation.

3.3 Semi-quantification of failure occurrence and failure detection degree

The semi-quantification of failure occurrence is analyze by synthesis the following aspects: the results of regular check, the failures occurred before, the failures occurred at the same kind of system, the degradation trend analysis of components.

Semi-quantification of detection degree may be classified by the faculty of the corresponding inspection equipments, which can be grouped in the following four categories:

- The signs without any advance warning, which have no methods of inspection and control as well as any experience to be learned;
- The signs that can be estimated by few veteran personnel based on their own experience, however, who themselves are not sure of them;
- The signs that can be detected by the indirect inspection methods integrated with other inspection methods ;
- The signs that can be detected by the direct inspection methods accurately but there is likelihood for the personnel of not having found them in time;
- The signs with warning of light and sound, which can be found in time.

3.4 Semi-quantification of risk evaluation

The endanger degree, failure occurrence and failure detection degree could be shown in the three-dimension coordination, as shown in Fig.2.The area close to the origin is lower risk area with lower risk value and the area far away from the origin is higher risk area with higher risk value.

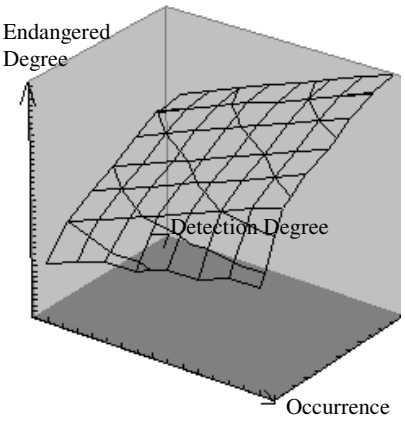

Fig.2 Risk value chart

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4 Maintenance strategies of equipment based on risk evaluation

(1) Personnel Selecting

It is important to select personnel with good command of special technology. Though it is optimal to have the maintenance unit handling the maintenance action, however, few of army possess the ability to inspect and repair the new equipment with the more and more complexity of equipment and introducing of newly technology. According to the experience of U.S. army, it is the only way to cooperate with contractor with technology capability involved.

(2) Analysis of the maintenance requirement

Based on the technique and the maintenance flow, all the equipments could be classified as four categories: key equipment, necessary equipment, assistant equipment and unimportant equipment, which lay the foundation for selecting the most appropriate maintenance technology for different kind of equipment. Above all, key equipment and corresponding technique should be controlled, which is of great significance for determining the successful maintenance strategies.

(3)Selecting maintenance technology

Select maintenance technology scientifically is another important thing during a maintenance action. With the development of technology, many advanced technologies have been integrated covering extensive fields, such as online vibration analysis, the analysis of oil and wear debris, infrared thermal imaging, accurate alignment and balance, the analysis of motor stator, the analysis of motor current, ultrasound etc.

In addition, the equipment systems can also be classified by the practice of equipment in army, such as: the equipment system that cannot be inspected and repaired during operation , the equipment system with spare system, the equipment without spare system, the equipment system that work in sequence and the equipment system can be inspected and repaired during the time interval between operations. Each of the equipment system should be established particular records based on the

above classification, including: name, quantity, purchasing time, performance parameter, the performance condition of regular check, past failure history records (time, station, cause, the negative effects), and so forth, along with the records of inspection and repair.

5 Summary

Risk-based maintenance is a maintenance strategy based on risk analysis and evaluation, which provides a simple, accurate and comprehensible guideline for the maintenance management modes of equipment or component. The process of risk-based maintenance can be summarized as: first, select feasible maintenance measures and technologies according to the different operation conditions, and then determine the maintenance period and the suitable personnel. However, to accomplish this, the risk-based maintenance should possess two preconditions: first, maintenance should be established on the base of analysis; second, maintenance should be developed on the base of information. The software of maintenance system should be involved with the basic information of equipment, the underlying failures and the corresponding modes, the failure consequences, the failure probability, the maintenance expense etc., at the same time, the maintenance resource and the maintenance actions should be standardization and coding.

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