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## Evolutionary Maintenance Based on Maintenance Free Operating Period Philosophy

Ming Xu, Yueqin Wu\*

*China Aero-Polytechnology Establishment, Beijing, 100028, China*

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### Abstract

Maintenance intervention is necessary for the system and equipment to maintain their operational performance during their lifetime. Maintenance and maintenance policy plays an importance role in achieving systems operational effectiveness at minimum cost. Accordingly, developing an optimal maintenance strategy to minimize maintenance costs is very important. This paper proposes a method to optimize maintenance strategy based on maintenance free operating period (MFOP), where MFOP philosophy is originated by the reliability office of the Royal Air Force. Furthermore, the optimal maintenance interval that meets the proposed reliability requirement is determined. In summary, the method not only can improve the traditional maintenance policies but also reflect the system changing states as components within them age.

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### 1. Introduction

In today's context of global competition, manufacturers are facing greater challenges than ever before. They need guarantee the customer that for a specified proportion of the operational time the overall system will not completely fail or lose enough functionality such that it cannot carry out all its assigned missions. For example, future military aircrafts are required to have the capability of completing long-range combat mission as well as lower life cycle cost by minimizing operating, maintenance and support cost. At the same time, future military aircrafts are required to

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\* Corresponding author. Tel.: +86-10-84380290; +fax: 86-10-64639893.;  
*E-mail address:* [wuyueqin@buaa.edu.cn](mailto:wuyueqin@buaa.edu.cn)

have the capability of quick deployment and the spreading of fighting across several areas. In order to reach his goal, Maintenance Free Operating Periods (MFOP) were first proposed by the MOD[1]. MFOP is the period of operation during which an item will be able to carry out all its assigned missions, without the operator being restricted in any way due to system faults or limitations, with the minimum of maintenance. It should be noticed that an MFOP is not defined to contain absolutely no maintenance, rather it is considered that minor actions, such as refueling, rearming and repairing important safety related features, will still need to take place. The Committee for Defense Equipment Reliability and Maintainability and the Ultra Reliable Aircraft consortia also has given the definition of MFOP. It is shown that MFOP is a period during which the system will operate without failure and without the need for any maintenance, however, faults and minor planned, contractually agreed maintenance are permissible[2]. The prime objective of maintenance is to ensure which a product can perform its intended functions. Since MFOP has the potential that can significantly improve the operational capability and reliability of the product applying it and therefore provide a way of better meeting the customer's needs, many reliability researchers have paid attention to it[3,4]. Generally maintenance includes corrective maintenance and preventive maintenance two main types. Corrective maintenance is an action that intended to restore the product to its operational state when the product has been already failed. Preventive maintenance is an action that performed in order to reduce the likelihood of failures and retain product in working state. Preventive maintenance can prevent the possibility of unwanted incidents occurring once the product is working. However to realize preventive maintenance not only need systematic inspection and detection but also need prevent some incipient failures. The aim of this research is to develop a maintenance method during the maintenance recovery period which would ensure the next MFOP and reduce life-cycle cost of products.

#### **Nomenclature**

MFOP The period during which the system will operate without failure and without the need for any maintenance, however, faults and minor planned, contractually agreed maintenance are permissible.  
 EM Evolutionary maintenance(EM) is a maintenance plan that includes corrective maintenance and age based preventive maintenance in which the policy age is adjusted after each MFOP.

## **2. Maintenance Free Operating Period**

The concept of maintenance free operating period (MFOP) is not new, it is essentially same as the warranty period. What is new is that the operators are considering extending this concept throughout the life of the system. In MFOP manufacturer will be asked to guarantee that no unscheduled maintenance activities will be need. In order to derive the MFOP with the required level of confidence, we need ensure some units life tracking and increase the reliability of unit in product.

### *2.1. Advantages*

Increasing consumer interest in their product is the key advantages of introducing MFOP. In this case the primary advantages will be linked to improving the purchase and whole life costs of the product or providing operational benefits. The main advantages of using MFOP include the predictability of maintenance periods which allows for overheads such as manpower and facilities to be used less often and with more planning, with little probability of emergency or reactive maintenance. Certainly products need not be available throughout a mission or series of missions, saving on costs or allowing for greater flexibility in mission planning. Another cost related benefit of using MFOP is making maintenance to be more efficient, by employing more powerful diagnostic tools, or planning repairs and spares better. During MFOP details of failures discovered could be transmitted back to the repair facility, allowing for spares and manpower to be made available. Overall successful application of MFOP will create a better chance of completing a mission and will reduce the time spent in the failed state.

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