
Research on the Repair Strategy of Green Maintenance

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Abstract: It is very important to realize the green maintenance by reducing the consumption of resource consumption and avoiding the environment pollution. This paper probes into the basic concept of the green maintenance, the green maintainability and the repair strategy, puts forward the train of thought, the principle, the accord and method, and the process of determining the repair strategy, and then illustrates it.

Key Words: Repair Strategy; Green Maintenance; Way of Determining the Repair Strategy

From the point of the sustainable development, it is very important to reduce the consumption of resource and avoid the environment pollution, especially for the maintenance. It will directly effect on the existence and development of the repair enterprise as it unable to meet the requirement of environment protection. Therefore, we must research on the green maintenance and its repair strategy with non-social harmful effect, non-pollution and re-suing resource.

1 The basic concept of green maintenance and its maintainability and repair strategy

1.1 Green Maintenance

Traditionally, maintenance means all activities that keep or restore the product (or equipment) to its

prescribed state. And, green maintenance means all activities that keep or restore the product (or equipment) to its prescribed state on the condition of taking into account the highest efficiency of using resource and the lowest environment pollution. Not only does it aim at the physical object of keeping and restoring the product to its prescribed state, but also aim at the sustainable development object of lowest environment pollution and highest efficiency of using resource for all activities start from maintenance to discarding as useless.

1.2 Green Maintainability

To realize the green maintenance, it should put forward the requirement of the green maintainability to the product and make the design of green maintainability form initial stages of product design. The green maintainability should be the inherent attribute of product when designing it. The green maintainability means the ability to keep or restore the product to its prescribed state when maintaining following the prescribed efficiency of using resource, prescribed maintenance condition and prescribed time and the prescribed procedure and method wit non-pollution. The requirement of green maintainability may also be adopted into the general maintenance requirements, such as the prescribed condition and prescribed procedure and method. So, two kinds of measurable requirements, the efficiency of using resource and the degree of non-pollution, maybe adopted into above-mentioned prescriptions.

(1)The efficiency of using resource (η)

The efficiency of using resource is ratio of the number of reusable unit (n) when the component

unit (or changeable unit) of product disabled to the total number of product unit (N). That is,

$$\eta = \frac{n}{N} \times 100\%$$

And, the number of reusable unit (n) includes two kinds of unit, which can be reused as the raw materials or reused as the component after repairing when disabled.

(2) The relative degree of non-pollution (H)

There are various kinds of pollution produced by maintenance, such as air pollution, water pollution, sound pollution, micro-wave pollution and radicalization pollution, etc. It should determine the degree of non-pollution of maintaining according to the prescriptions issued by the department of environment protection. The relative degree of non-pollution (H) may be used to describe the measurable requirement to green maintainability in non-pollution, which is the ratio of full pollution quantity (H_i) of product maintaining to highest prescribed quantity (H_0) granted by the department of environment protection. That is,

$$H = \frac{H_i}{H_0} \times 100\%$$

When there are n kinds of pollutions,

$$H = \sum_{i=1}^n \lambda_i \frac{H_{li}}{H_{0i}} \times$$

100%

And, λ_i is the weight of the number i

$$\text{pollution, } \sum_{i=1}^n \lambda_i = 1$$

1.3 The repair strategy of green maintenance

In order to be convenient to the design of green maintainability, it should put forward the assumption of repair strategy of green maintenance in the initial stages of product design. Generally, repair strategy is to assume the product system and its components to be maintainable, part maintainable or un-maintainable when failure, which includes the maintain site and the manner and approach of dealing with the discarded parts. The repair strategy will directly effect on the design of maintenance, the course of maintenance and the establishment of support system.

2 The train of thought, the principle, the accord and method of determining the repair strategy of green maintenance

2.1 The train of thought and the principle of determining the repair strategy of green maintenance

The main train of thought of determining repair strategy of green maintenance is to parallel with the product design and the Reliability, Maintainability and Supportability (RMS) engineering, wholly optimize the system and synthetically balance, from the initial design to modifying the design and to carrying out the design.

The principle of determining repair strategy of green maintenance is to carry out two kinds of measurable requirement of green maintainability, including the efficiency of using resource and the

degree of non-pollution, to achieve the object of the lowest environment pollution and the highest efficiency of using resource. The concrete principle includes:

(1)The Repairable Principle. It should take the part repairable strategy and the full repairable strategy as possible when granted. Therefore, the repair units should adopt the advanced repair technology, make the technological innovation and improve the repair measure, such as the rapid laser molding and processing technology, surface engineering technology, burying welding technology, non-cyanogen plating technology and other green cleanout technology, etc. And, it should consider to disassembling the product to the lowest level of repair unit when designing the structure.

(2)The Reusable Principle. It should take full use of the parts and the components to be discarded as useless on the basis of technological detecting. Some maybe transform to other use or demoted using, such as the operational equipment transforming to training equipment, military equipment transforming to civil equipment. Some maybe reused as the raw materials by crushing, disassembling or synthesizing and deoxidizing. It should take the circular use into account when designing the structure of product, the parts and the components, required to be callback for reuse, should be designed as easy to disassemble, replace and pack. The main structure should choose the green materials which can be used repetitiously and will not pollute the environment when processing the castoff, under the condition of ensure the product performance.

(3)The Non-pollution Principle. When

determining the repair strategy of green maintenance, it should take the materials and the repair measure with non-pollution or low-pollution as possible, and choose the unit able to carry out repair work with non-pollution or low-pollution. When discarding those parts and components unable to be reused, it should consider whether it is deleterious or polluted.

(4)The Economical principle. When determining the repair strategy of green maintenance, it should evaluate and compare the repair expenditure of each maintenance level, the expenditure of reusing or discarding the components, all include the accessorial repair item and expenditure due to harmful to the environment when repairing. It should take the repairable strategy when the repair expenditure lower than or near to the discarding expenditure.

2.2 The accord and method of determining the repair strategy of green maintenance

The accord and the method of determining the repair strategy of green maintenance is similar to those of determining the strategy of general repair, the difference between them is that it emphasis on adopting the repair strategy with lowest environment pollution and highest efficiency of using resource. We should pay attention to those:

(1) It should collect as more information about the repairing object and similar product (i.e. similar parts or components) as possible, such as the repairing ability of each maintenance level, the repairing technology, the expenditure, whether it will pollute the environment or not and the degree of harm, etc. And the information about the similar

product (i.e. similar parts or components) is particularly important to determine the preliminary repair strategy.

(2) When determining the repair strategy of green maintenance initially, it should take full use of the gathered information to determine the maintenance mission as the basis of determining the repair strategy. It should take the requirements of green maintenance into account, such as the Failure Mode, Effect and Criticality Analysis (FMECA), Damage Mode and Effect Analysis (DMEA), Reliability Centered Maintenance (RCMA), Level of Repair Analysis (LORA) and economical analysis, etc, when determining the maintenance mission. The method mentioned above refers to relative criterion and books. And, the failure effect and the damage effect of FMECA and DMEA should be considered thoroughly and taken into the effect to environment. The failure effecting the environment beyond the standard should be taken as the security effect to determine the maintenance mission during the process of RCMA. The non-pollution principle should be adopted into the non-economical analysis, and should choose those units with non-pollution or lowest-pollution to carry out the work during the process of LORA. It should take the accessorial items and expenditure due to it harms to the environment into the expenditure during the process of economical analysis.

3 The process of determining the repair strategy of green maintenance and illustration

3.1 The process of determining the repair strategy of green maintenance

The process of determining the repair strategy

of green maintenance refers to the figure 1.

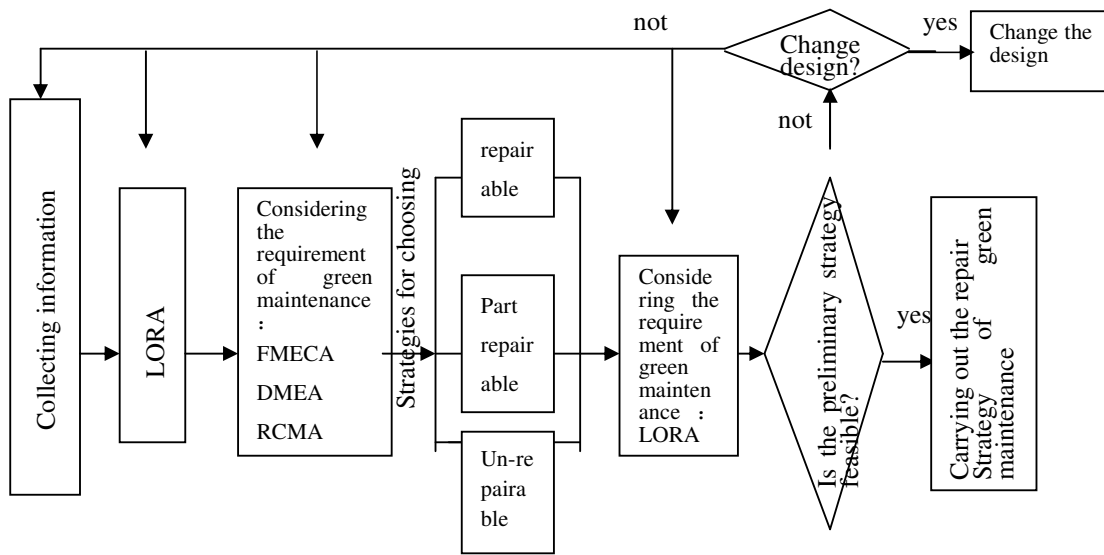


Figure 1 The process of determining the repair strategy of green maintenance

The FMECA, DMEA, RCMA considering the requirement of green maintenance is to determine the maintenance mission preliminarily, and export the preliminary repair strategy by LORA. It should evaluate the feasibility of the preliminary repair strategy according to the repair strategy principle of green maintenance, and then determine the strategy after analyzing again and again.

3.2 The illustration of the process of

determining the repair strategy of green maintenance

The movement damp device of a type of equipment is the liquid damp, which consists of the damp liquid, the piston (including piston set and the piston pole) and the piston canister. Part of the FMECA, DMEA and RCMA refers to figure 2.

Figure 2 The FMECA, DMEA and RCMA of the movement damp device

Name and Number	Function and Symbol	Failure Mode	Cause of Failure	Phase of Mission	Effect of Failure				Detecting method of failure	Sort of Rigor	Repair Mission	Analysis Information
					Part Effect	Higher Level Effect	Final Effect	Environmental Effect				
16011 Piston Set	1Working with other components to provide damp	A The movement part moves too long	1The piston set worn	Working	worn	Move too long	The equipment doesn't work	no	Shutdown and measure	II	Brush plating	Maybe repaired by the department of motor of the repair factory
16012 Piston Pole	1Transferring damp	A No resistance	1 movement blocked	working	broken	Part strike to equipment	Part damage to the equipment	no	Measure the block with eyeballing	I	Put the block in order, discard the piston pole	Unworthy to repair, callback and use the discarded parts
1602 Damp Liquid	1Working with other components to provide dam	A The movement part moves too long	The damp liquid metamorphose	Working and shutdown	metamorphose	Move too long	The equipment doesn't work	The discarded liquid pollutes the environment	Measure the ph	II	Change the damp liquid	use clean-polluted damp liquid
1603 Piston Canister	1 Working with other components to provide dam	A The movement part moves too long	1The piston canister worn	working	worn	Move too long	The equipment doesn't work	Chromeplate is polluted	Shutdown and measure	II	Repair the chrome layer	The repair factory may adopt the chrome layer replacing repair technology with nonpollution

It can preliminarily determine the maintenance mission on the basis of initial analysis above, and then determine the initial repair strategy by using the analysis information in the figure and make the LORA, and finally, determine the repair strategy of green maintenance by analyzing again and again. The final strategy is that the movement damp device is part repairable, the piston set maybe repaired by the motor department of the repair factory (intermediate maintenance), the piston pole is un-repairable and it maybe callback for other use, and the piston canister maybe repaired by the repair factory (depot maintenance), and the damp liquid maybe changed by the maintenance man in workshop (organizational maintenance),etc.

4 Conclusion

The problem of environment protection and the problem of reducing the consumption of resource are the urgent problem we should solve for sustainable development in 21st century. The green maintenance is helpful to reduce the consumption of resource and avoid the environment pollution. Therefore, the green maintenance, the green maintainability, the repair strategy of green maintenance and the advanced repair technology with non-pollution are all the questions that should be researched and answered.