

The Application of MMS on Unscheduled Maintenance of Transrapid

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Maglev vehicle, maintenance management system, vehicle diagnosis system, unscheduled maintenance

Abstract

Shanghai Maglev Transportation Development Co., Ltd. (SMTDC) developed and implemented the maintenance management system (MMS) aimed at supporting the maintenance management of maglev system during the construction period of shanghai maglev line. At present, MMS has been put into full utilization in the maintenance work of all operation core systems, i.e. operation control system, propulsion and power supply system, guideway and maglev vehicle, in shanghai maglev line.

The application of MMS started from the support of maintenance of maglev vehicles during the period of commissioning. This paper analyzed the whole process of the unscheduled maintenance of maglev vehicle (also called Transrapid) consisted of diagnosis interface, failure reporting, work order management and performance evaluation, intends to introduce and summary the application features of MMS on the unscheduled maintenance of maglev system.

1 Introduction

In order to ensure that the Shanghai Maglev commercial demonstration operation line can be put into service successfully, Shanghai Maglev Transportation Development Co., Ltd. (SMTDC) developed and implemented the maintenance management system (MMS) aimed at supporting the maintenance management of maglev system during the construction period of shanghai maglev line. At present, the MMS has been put into full utilization in the maintenance work of all operation core systems, i.e. operation control system, propulsion and power supply system, guideway and maglev vehicle, in shanghai maglev line, with prominent effects obtained.

The application of MMS started from the support of maintenance of maglev vehicles during the period of commissioning. This paper analyzed the whole process of the unscheduled maintenance of maglev vehicle consisted of diagnosis interface, failure reporting, work order management and performance evaluation, intends to introduce and summary the application features of MMS on the unscheduled maintenance of maglev system.

2 Online diagnosis system-based unscheduled maintenance

The maintenance of maglev system, which consists of scheduled and unscheduled maintenance, is carried out based on the strategy of the combination of status-based and preventive maintenance. Unscheduled maintenance is more important to those technically advanced and complex sub-systems such as vehicles, propulsion, and control system.

The unscheduled maintenance activities can be initiated by messages from the diagnosis and inspection systems, the maintenance or the operating personnel. During the period of revenue operation, online diagnosis system-based unscheduled maintenance will become the main measures.

The basic concept of the online diagnosis system-based unscheduled maintenance of maglev vehicles is illustrated in Fig. 1, and the corresponding flow chart using MMS is shown in Fig 2.

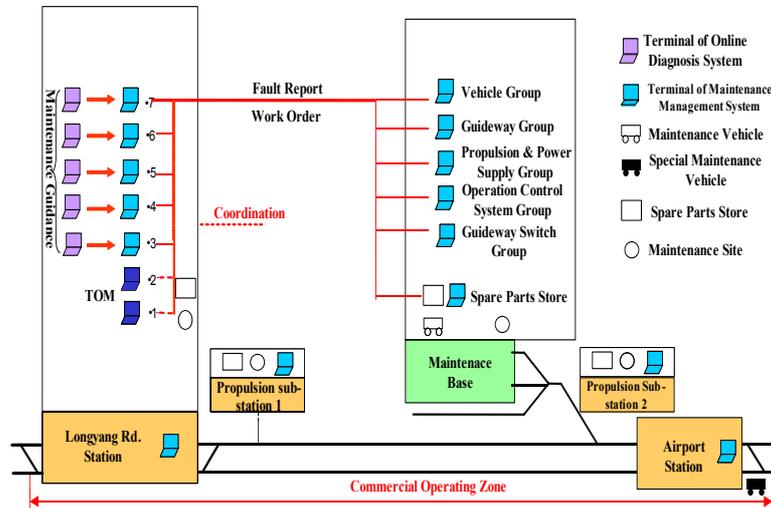


Fig. 1 Schematic of the unscheduled maintenance of the maglev vehicle

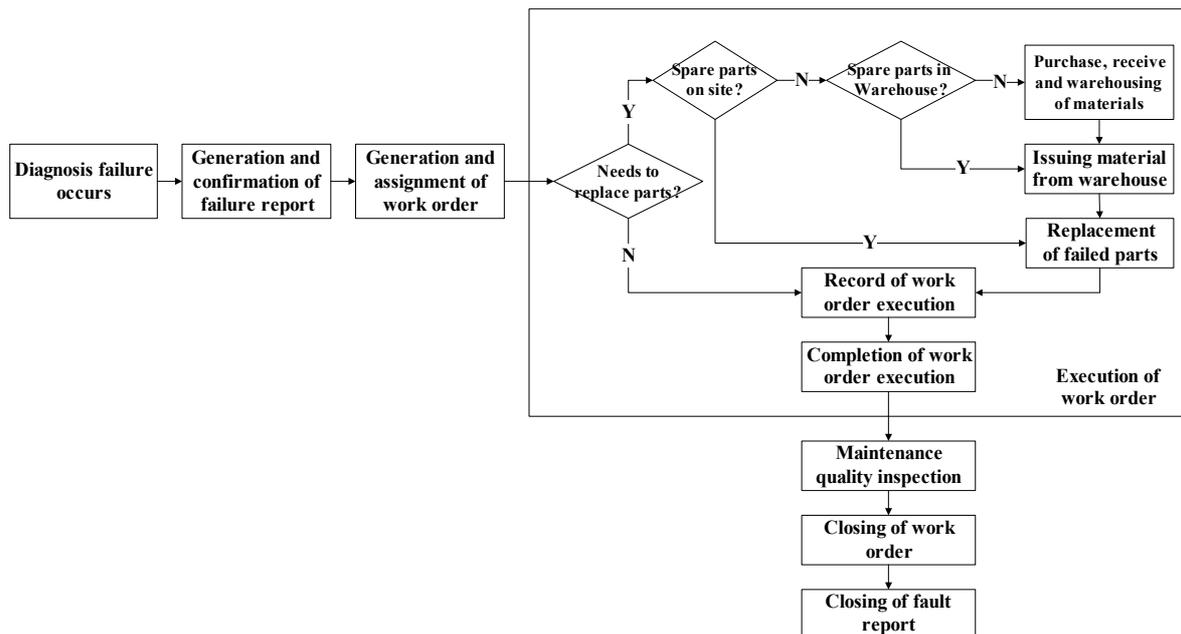


Fig. 2 Flow chart of the unscheduled maintenance of maglev vehicle using MMS

Vehicle Diagnosis System (VDS), locating in the operational control center of Longyang Road Station, displays the on-line vehicle diagnosis information on the diagnosis terminals. In the meantime, MMS will acquire the on-line diagnosis information through diagnosis interface between MMS and VDS, and generate the failure report. Normally, vehicle maintenance personnel in the maintenance area will work based on the work order issued by the operational control center through MMS. The maintenance personnel shall record the defective symptom, analyze the failure root cause, perform the planning and control the maintenance schedule and evaluate the performance utilizing the

functional modules such as failure reporting, work order, equipment history, documents management and operational management of MMS.

3 Vehicle diagnosis interface

VDS is a network-based system, consists of onboard vehicle diagnosis system, centralized diagnosis system and diagnosis terminal. The diagnosis information is transmitted to the centralized diagnosis system through the radio system and wide area network from the onboard diagnosis system.

The onboard vehicle diagnosis system will periodically collect the equipment diagnosis information and perform the analysis, calculation and comparison of the diagnosis information with the failure list of the equipment obtained. The diagnosis information includes the diagnosis information identification, diagnosis component, location of the part, state of the part, diagnosis position and date and time, etc.

The centralized diagnosis system of VDS stores the diagnosis information into the database to provide data service to each diagnosis terminal. In the meantime, the vehicle diagnosis system shall transmit the records of the diagnosis information to the MMS in the form of text format. MMS shall interpret the diagnosis information in the text format into the failure information of the diagnosis, status information of the vehicle, etc, in accordance with a certain rule and store the information in the database of MMS. This kind of special interface is adopted to ensure the accuracy of the transmitted information and correctness and integrity of the data.

4 Failure report

MMS generates failure report through acquiring the real-time VDS failure diagnosis information from the vehicle diagnosis interface. The flow chart of the transaction treatment of the failure report in MMS is illustrated in Fig 3.

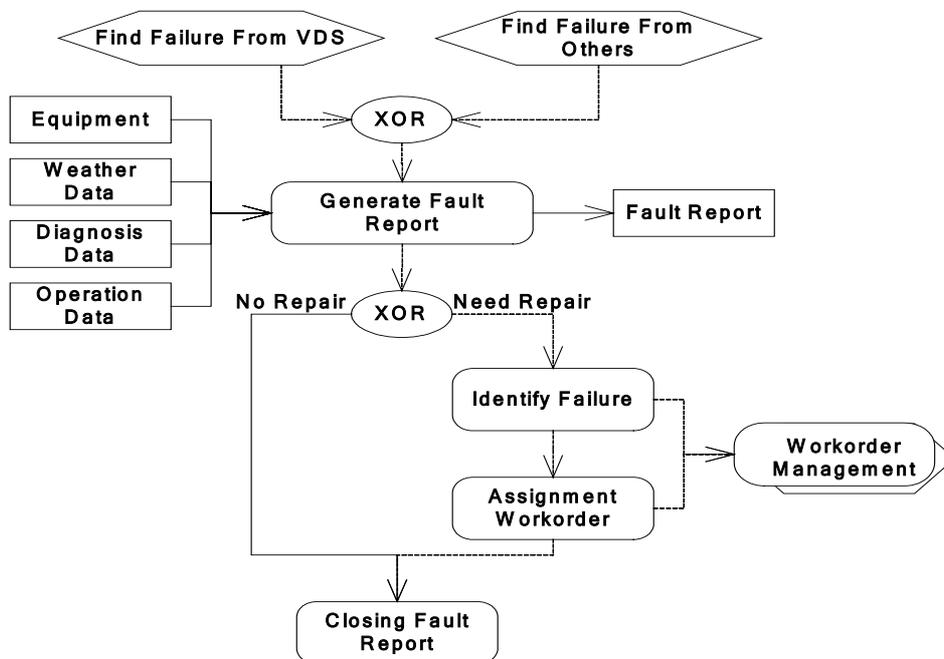


Fig. 3 Flow chart of the transaction treatment of the failure report

MMS failure reports establish the relationship between the phenomena, causes and solutions, which is very important to the accumulation of the experiences in the unscheduled maintenance of the maglev vehicle and failure analysis.

In the process of eliminating the failures, analysis and documents of the failure are to be finished and reported through the joint signature by failure reporter, maintenance manager, subsystem supervisor and quality inspector through MMS.

5 Work order management

After the failure report is generated and confirmed, the maintenance administrator should arrange the work order to eliminate the failure. The work order is the media to record the maintenance operation and holds a very important position in the system: it's used to identify the responsibilities and mutual relationship of the maintenance operations, plan and control the resources necessary for the maintenance, record the contents of the relative works in details, and lay down the data foundation for the analysis of the critical performance indices of the maintenance.

MMS is unique to the normal commercial maintenance management, in the area such as the control of the state of the work order flowchart, plan and control of resources, parts replacement, linking of documents and release of vehicles.

- Control of the state of the work order flowchart

There're several states in the life cycle of work order from opening to closing, which shown in Fig 4. The system provides a method to control the state of the flowchart to normalize the behavior of the change of the states of the work order. When the change of states occurred, the system will record the operator implementing the change of the state, the operation time and the remarks from the operator.

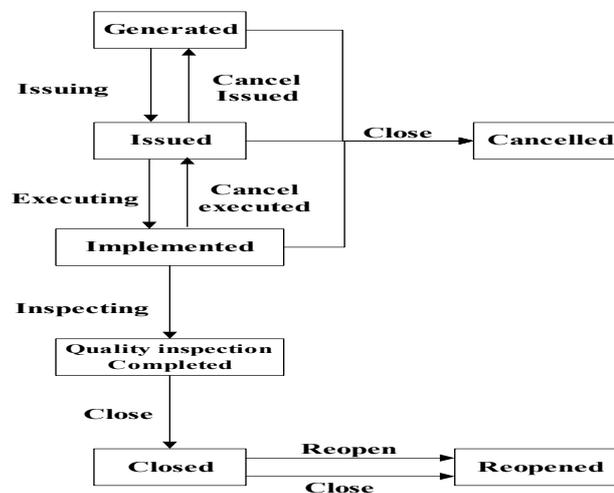


Fig. 4 Change of the state of the work order

- Plan and control of the resources

The plan and control of the resources is realized through establishing the relationships between the states of work order. Before the state of the work order becomes “issued”, the maintenance planner can fill the planning information about the resources, to define the planned steps for the operation and the necessary workload, name and quantity of tools or materials. After the state of the work order becomes “issued”, the operators may give feedback on the actual information concerning the operation

of the work order, to identify the actual steps of the operation and actually consumed workload, name and quantity of the materials or tools. To other states, it is impossible for the operator to change the information about the resources.

- Parts replacement

In order to support the parts replacement work, MMS provides a convenient function to search quickly the distribution of the parts similar to the failure part used for selection. If the part is available in the warehouse, it can be withdrawn directly from the warehouse with the material withdrawal sheet. In replacement of the part, it is necessary for the operator to complete the number of the part to be replaced and the number of the replacing part only. The system will automatically judge the interchange ability of the parts, with the performance of replacement of the two parts and relevant recording of the lifecycle if they are interchangeable. If the part contains any sub components, the system can ensure the accurate correspondence of the parts in the relationship of the position based on the structure of the part position, with automatic interchange of the sub component and the relevant recording of the lifecycle. The adoption of this kind of part replacing operation is possible to improve the efficiency of lifecycle recording and enhance the accuracy of the part positioning, so as to raise the efficiency level of the maintenance operation. It is especially suitable for the maintenance operation involving changing of the positions of a large numbers of parts such as the vehicle grouping.

- Documents linking

In certain instances, it may be impossible to make the structuralized saving of the information in the execution of the maintenance. MMS provides a document function to solve the problem. The operator may save the information in the form of electronic file. Then, the file is to be linked with the special work order to realize the complete recording of the work order information. All the relevant information concerning the file will be saved in a file server in centralized mode. For example, a picture may be taken of the phenomenon of the failure and saved. The adoption of this mode of recording files is advantageous to the perfection of the records of the maintenance operation, to strengthen the sharing of the filing data, helpful to the exchange of the working experiences in the maintenance.

- Release of vehicles

In order to improve the safety of the vehicles and personnel in the maintenance, the relationship between the work order and safe release of the equipment should be established, if the maintenance work order affects the safety of the equipment. For a certain unit of equipment to be released, when there is any work order or failure report being unclosed or in process, warning information shall be provided and the equipment shall not be released. The adoption of the equipment safe release could enhance the safety of the equipment and personnel.

In the practice of the maglev vehicle maintenance, the MMS features which mentioned above described provide strong support to the unscheduled maintenance management for the maglev vehicles.

6 Post-job evaluation

After the elimination of the failure, it is necessary to make a summary of the work, to analyze the effects of the operation and the maintenance performance of the equipment. It will be advantageous to the problem detection in the management or in the working condition of the equipment, for reference to make decision on the maintenance management. Viewing from the execution process of the unscheduled maintenance, the analysis to be provided shall mainly cover two major aspects: failure analysis and evaluation of the key performance.

The failure analysis is mainly based on the failure symptom, cause and solution of the failure as well as the defect equipment, to analyze the rule of the occurrence of the failures and find out the root cause where failures occurred frequently and the distribution of the failures as well as the decision-making tree for the failure analysis.

The evaluation of the key performances is to be made mainly from two perspectives, i.e. equipment and execution (or man). At present, the evaluation of the key performances mainly includes:

- Statistics of the quantity of the states of the work order (result analysis)
- Statistics of the history of the states of the work order (process analysis)
- Statistics of working hours
- Statistics of the history of the maintenance of the positional and function objects (complexity of the maintenance)
- Statistics of the failure of the position and function objects

7 Concluding remarks

It is a significant innovation to apply MMS in the unscheduled maintenance of maglev vehicle under commercialized operation, especially in failure report, work order and performance evaluation.

Currently, the application of MMS in the shanghai maglev line for the unscheduled maintenance of the maglev vehicle is becoming mature and moving towards a higher target. With the deepening study of the failure and indices of the statistics of the maintenance of the maglev vehicle running in the Shanghai Maglev Line, the management of the unscheduled maintenance of the maglev vehicle will be further enhanced. This practice is also meaningful for reference for the equipment maintenance management in other rail traffic projects and assets intensive enterprises.