Research on EMU on-condition maintenance Process Based on Advance Warning

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Abstract. According to the maintenance characteristics of EMU, design EMU on-condition maintenance rule model. Suggestions for EMU maintenance are put forward based on EMU on-condition maintenance rule model. In addition, the maintenance advice will be passed to EMIS. In the EMIS plan, the job model to carry on the process structure comprehensive penetration, and the results are fed back to the on-condition maintenance model as input data..

1. Introduction

Scientific and reasonable repair class and repair system is an important guarantee for efficient, safe and economic operation of EMU. The existing domestic EMU repair class and repair system program is to a large extent a comprehensive and continuation of the repair system of foreign EMU, and fails to fully consider the specific operating conditions of domestic EMU. The current repair class and repair system program still needs to be further improved according to the specific operating conditions in China. At present, China's EMU implements the maintenance system of "planned preventive maintenance as the main, maintenance after the supplement", and the maintenance cycle adopts the mode of traveling kilometers as the main and time as the supplementary. The current maintenance system of China's EMU can basically meet the needs of the safety operation of EMU. However, with the in-depth study of the degradation law of the service performance of EMU in the whole life cycle, it is found that the planned preventive repair system also has drawbacks such as "insufficient maintenance, over maintenance, low efficiency and waste of maintenance cost" in the practical application process.

In view of the above problems, the professional data of EMU is collected to realize the monitoring of the health status of the whole vehicle and its components. The rule model is used to evaluate the parameters, and the corresponding maintenance suggestions are given for the maintenance projects of each component of EMU.[1] And with the existing production system through, to guide the on-site maintenance operations, the real implementation of planned preventive maintenance to maintenance according to the situation of the change.

2. Research and Design of Rule Model

The model is compiled around "accessory type" or specific "accessory", and can support multiple "accessory type" and "accessory" simultaneously.[2] The effective EMU in which the model is effective is controlled by the model itself (the effective EMU filtering can be realized through the EMU dictionary, allocation and other interfaces (Filtering of effective EMU can be realized through interfaces such as EMU dictionary and distribution.).[3]
The model is composed of "model basic information", "information code", "maintenance content", "maintenance content and maintenance project correlation relationship", and "correlation parameters", the model relationships are shown in Figure 1. [4]

![Fig.1 Model Diagram](image)

2.1. Basic Model Information
The basic information of model mainly includes model code, model name, model type, description, research unit and so on. [5] The model types include: early warning model (MC), condition-based maintenance model (MO) and health assessment model (MH). The purpose of setting the model types is to expand the model in the future. In this paper, only the on-condition maintenance model is used. [6] Such as:

Data format: Model encode| model name| model type| description | research unit
Data example: TK0001 | fault warning model for traction motor temperature | MC | for CRH380B/BL, CR400BF/BF-A, XXXXX|8 6/5000

2.2. Information Code
The model sets the Info Code for each of the different phenomena of the accessory type or accessory it supports, and the Info Code under the same model is unique.
The same information code under the same model can only be configured with one accessory type or one accessory. The information code mainly includes model type, model code, information code, information display name, system, grade, description information, emergency disposal suggestion, driver disposal suggestion, storage disposal suggestion, accessory type ID and accessory ID. The accessory ID is set only when the model is compiled for a specific "accessory". The default is null.

Such as:
Data format: model type| model code| information code| information display name| system | stage| description information| emergency disposal suggestions| driver disposal suggestions| library disposal suggestions| accessory type ID| accessory ID
Data example: MC | TK0001| Q0001| Motor drive end bearing temperature jump |5000|2| the absolute temperature difference is greater than 20 degrees C, occurred twice in 10 minutes and the speed is greater than 0| XXXX emergency disposal | XXXXX driver disposal | XXXX library disposal | 356 |

2.3. Maintenance Content
Since each information code corresponds to a kind of "accessory type" or "accessory" phenomenon, the maintenance suggestion for this phenomenon is the "maintenance content".[3]

Maintenance content mainly includes: model type, coding, maintenance content coding, maintenance content display name. Among them, the warning model is not configured with "maintenance content". Such as:
Data format: model type| model encoding and information code| access content encoding| and service content display name
Data example: MC | TK0002&Q0001| XD0001 | ventilation measurement
MC| TK0002&Q0001| XD0002 | the dust tank clean

2.4. Relation between Maintenance Content and Maintenance Items
When the maintenance suggestions are pushed to the EMIS, the actual "maintenance items" should be pushed, that is, the "maintenance contents" of the model should be correlated with the "maintenance items" of different segment-level units in the production environment.
The correlation relationship mainly includes model type, code, maintenance content code, segment unit code and maintenance item code. Among them, "segment unit code" and "maintenance item code" can uniquely locate a "maintenance item".[8]

Such as:
Scenario: Ventilation volume measurement corresponds to three segment units of "Ventilation Volume Measurement Project". The maintenance item code of segment 00565 and segment 00566 is consistent, while the maintenance item code of segment 00567 is CRH000021.
Data format: model type| model encoding and information code| access content encoding| segment unit code | access item coding
Data example: MC | TK0002&Q0001| XD0001|00565| CRH000005

2.5. Correlation Parameters
The model needs to analyze the phenomenon of "accessory type" or "accessory" according to the parameter realization.[9] Through "associated parameters", the business user's ability to analyze the data can be enhanced.
The association relationship mainly includes type, parameter source, No. 24 model code, WTDS protocol code, model code & information code, threshold upper limit, threshold lower limit, carriage, protocol parameter code, and whether to span a carriage. Among them, when the carriage is 00, it means the whole car.[10]

Such as:
Data format: Type | source | number 24 model | WTDS Protocol Code | Model Code | National Code | Threshold Upper Limit| Lower Threshold | Carriers| Protocol Parameter Code| whether it spans carriers
Data example: MC|03|CRH380B|CRH380BK|TK0005&M0001|100|50|8|0

2.6. For Model Result
The relevant data of EMU are taken as the input data of on-condition maintenance model, and the maintenance suggestions are output. Suggestions for maintenance as appropriate include model number, information code, time stamp of calculated data, vehicle type on the road, four-digit crew number, carriage number, detailed description, status, list of maintenance contents, ID of parts type, name of parts type, code of relative carriage position, and name of relative carriage position.

2.7. Review and Dispose of Information
Depending on the situation, the maintenance suggestions are transmitted to the EMU production system for manual review, and the review results mainly include: review time, review results, disposal time, disposal results and disposal details, among which the disposal results include confirmed and false positives.

3. On-condition Maintenance Process Design
The condition-based maintenance suggestions output by the condition-based maintenance early-warning model will be transmitted to the EMU production management system to carry out process running and output closed-loop results. The on-condition maintenance running process is shown in Figure 2.

- Plan Management Module: Arrange the maintenance schedule for the adopted maintenance suggestions.
- Plan Management Module: The maintenance foreman assigns the personnel to assign the work, and generates the maintenance item record sheet.
- Job management module: Backfill maintenance items for ground mechanics after work.
- Job management module: Confirm the maintenance content corresponding to the function bit in the PHM maintenance recommendation.
- Maintenance model for PHM as appropriate. Provide data support.
- Performance record

Fig.2 On-condition Maintenance Running Process

3.1. Send On-condition Maintenance Suggestions
Maintenance recommendations will be sent to EMIS as appropriate, with key contents including EMU, compartment, function bit, model, model output code, maintenance content, time, etc. Whether need to verify before sending as recommended maintenance is associated with a functional coding of parts.
3.2. Plan and Assign Workers
Determine whether the maintenance advice is adopted according to the situation? Adopted suggestions to directly arrange maintenance plan, and at the same time in this module can be issued normal plan preventive repair items. Carry out work assignment, maintenance foreman assign personnel to carry out work assignment, generate maintenance project record sheet.

3.3. Homework and Backfill
Backfill maintenance items for ground mechanics after work. And the maintenance content of the functional parts given by the PHM maintenance recommendations is confirmed. Actual performance records are collected to provide data for on-condition maintenance models.

4. Conclusion
According to the maintenance characteristics of EMU, the detailed design of the maintenance model of EMU is given. The process after transferring the condition-based maintenance model to EMU management information system is studied, and the comprehensive structuralization of condition-based maintenance is realized. It provides the basis for the comprehensive transformation from preventive maintenance to condition-based maintenance of EMU.

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