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Some Thoughts on Reducing the Maintenance Cost of Electromechanical Equipment in Urban Rail Transit

Zhoushen Xu[1], Yuandong Hu[2]

[1]Operating Company, Ningbo Rail Transit Group Co., Ltd, Ningbo 315000, Zhejiang Province, China;

[2]Zhuhai Marine Environmental Monitoring Central Station of South China Sea Branch, SOA, Zhuhai 519015, Guangdong Province China.

Abstract

As one of the important components of urban passenger transportation, the safe and stable operation of urban rail transit has always affected the general public travel. Through the analysis of the main problems in the field of mechanical and electrical maintenance of urban rail transit in China, the maintenance cost of enterprises can be reduced, the maintenance management structure of mechanical and electrical equipment can be improved, the stable development of urban rail transit industry can be promoted, and the sustainable and efficient development of society can be guaranteed.

Keywords

Urban Rail Transit; Electromechanical Equipment; Maintenance Cost.

1. Introduction

With the rapid development of economy, science and technology, China has become one of the countries with the largest development speed and scale of urban rail transit in the world. By the end of 2018, 35 cities in mainland China have opened urban rail transit, with 185 operating lines and a total length of 5761.4 km [1]. At the same time, the smooth operation of electromechanical equipment is closely related to the comfort of passengers, as a consequence, the maintenance of electromechanical equipment of rail transit is more and more valued. How to scientifically and reasonably allocate the maintenance resources of electromechanical equipment of rail transit, improve the safety operation reliability of electromechanical equipment, and reduce the maintenance cost as much as possible? The importance of promoting the sustainable development of urban rail transit is in front of managers responsible for the operation.

2. Problems existing in maintenance cost management of electromechanical equipment in urban rail transit.

The electromechanical equipment in urban rail transit is mainly composed of water supply and drainage system, low-voltage power supply system, environmental control system, platform door system, AFC system, automation system, etc. Among these, the main maintenance costs include the spare part and material cost, consumable cost, labor cost, depreciation of relevant tools and instruments, use cost of required vehicles etc, which can be further divided into two parts including the direct cost and indirect cost [2]. Combined with the practical application of maintenance cost management, there are still several problems.

(1) The accuracy of purchasing spare parts of electromechanical equipment is generally not high. Due to the characteristics of the electromechanical equipment in urban rail transit, relevant equipment is various and complex. Even if the same line is constructed in the same batch, the equipment between

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different stations is not the same. This brings great difficulties to the maintenance of electromechanical equipment. Also, due to the complexity of equipment specifications and models, high requirements are put forward for the purchase of spare parts. The current main idea is to purchase a certain amount of spare parts for the same specification and model of equipment in the line according to the number of equipment installation. However, in practical application, it is frequently necessary to replace a small number of equipment without spare parts. Therefore, the accuracy of purchasing spare parts for the electromechanical equipment in urban rail transit is not high, which causes a considerable inventory backlog at the same time.

(2) The general working level of spare parts of electromechanical equipment is low. Considering the maintenance of electromechanical equipment in urban rail transit at present, the common way is to replace the faulty equipment with spare parts of the same brand, specification and model. On account that there are different manufacturers and suppliers for each electromechanical subsystem, some flexible units have to use the products from various manufacturers or suppliers. For example, the functions of the electrical components in the fan distribution box of the environmental control system are similar to those in distribution box of the water chiller of the environmental control system. In fact, products from different manufacturers are employed. As a consequence, this situation aggravates the complexity of the brand and model of the electromechanical equipment, and also increases the pressure of inventory.

(3) The procurement period of spare parts of electromechanical equipment is long. The vast majority of domestic rail transit operation and maintenance enterprises are state-owned enterprises. Considering the characteristics of the state-owned enterprise system, the procurement method is to package the spare parts for public bidding. Due to the complexity and diversity of goods in the bag, there are frequently dozens or hundreds of manufacturers involved. Also, due to the factors of product renewal and adjustment of manufacturer's production and operation, clarification of product technical parameters often occurs in the process of cost and bidding, which delays the procurement cycle. The lengthy procurement process reduces the efficiency of troubleshooting.

(4) The brand source of spare parts of electromechanical equipment is single, and the procurement cost is high. In the construction of rail transit project, the subsystem equipment is generally supplied by the bid winning manufacturer as a whole. In the actual supply, most of the general components experience the second transformation after the bought-in components were purchased. In fact, the quotation of the equipment after the second transformation can be several times or even dozens of times that of the previous procurement, which causes a lot of procurement cost pressure for rail transit operation enterprises.

(5) Excessive pursuit of expensive tools and instruments. Due to the particularity of rail transit, safety and stability are the eternal theme of rail transit operation enterprises [3]. As a result, there are high requirements for the safe and stable operation of some electromechanical equipment closely related to traffic and passenger flow. However, some professional groups of the operation unit are too keen on the high-end tools and instruments, and the configuration of individual tools and instruments for the team is too high, which greatly exceeds the requirements of normal maintenance. Moreover, due to the high value, a large part of them are fixed assets. The team members are worried about the damage of tools and instruments and do not want to use them, will not use them, and dare not use them, resulting in the idle of fixed assets.

(6) Lack of maintenance skills and weak awareness of independent innovation. In a maintenance team, the personnel are basically fixed according to the preparation requirements. Routine inspection, maintenance and troubleshooting personnel can basically meet the maintenance requirements of electromechanical equipment. But this often leads to the monotony of the team, especially in the absence of relevant incentive system, the team members have strong thinking of "none of my business" and "dawdling", which makes the whole team gradually faint and lack of initiative. For example, a simple fault handling such as the replacement of lighting source in the station can be assigned 5-10 people (accounting for more than half of the number of people in a team). For complex

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faults, no one wants to deal with them, no one dares to deal with them. Instead, they turn to the technical support from the manufacturer. In the long run, technology and spare parts are more subject to the manufacturer.

(7) The period of spare parts in stock is too long, and necessary maintenance measures are lacking. Looking at the rail transit lines that have been opened in China, a large part of them have been opened for more than six years [4]. It is understood that most of the urban rail transit operators lack maintenance of stored spare parts. For example, the lubrication of spare pump valve, the regular test of server circuit board, etc., which are easy to lead to the failure of spare parts. These practices cost money due to long-term storage, resulting in unnecessary wastes.

(8) The procurement process blindly pursues low price bid winning. In general, rail transit operating enterprises in China suffer losses [1]. Due to the limitation of indicators put forward by State-owned Assets Supervision and Administration Commission (SASAC) and financial departments at all levels, cost reduction is put in a very important position by all operating units. Especially in the field of bidding for spare parts and technical transformation, most of the models are the lowest price. As a result, when supplying equipment, suppliers have to find new sources due to the low quotation, which leads to a long supply period, and it is not uncommon for them to replace superior products with inferior ones and stick the brand of products. In addition, the supplier cannot perform the contract normally due to the long supply period, which leads to the cancellation of the contract, so the bidding process must be restarted. Such phenomena seriously affect the arrival and utilization of spare parts and consumables related to normal maintenance. As a result, the electromechanical equipment of rail transit cannot run safely and stably.

3. Measures and methods to alleviate and solve related problems

The planning, design, construction and operation of rail transit are all jointly operated by several or even dozens of departments of a local government [5]. As an operation unit, it can only try to make some changes from the perspective of operation and maintenance of electromechanical equipment of rail transit. Although it may not completely solve the problem, it can greatly alleviate the phenomenon of the problem and achieve immediate results.

(1) Optimize team management and stimulate everyone's enthusiasm. The management mode of "more work, more pay" can be carried out for team members, and the working mode can be classified. That is to say, it is considered to strengthen the salary reward for some personnel involved in night maintenance and technical backbones who are active in troubleshooting, to reduce the salary reward for personnel with low maintenance efficiency and improper working attitude, and to maintain the salary of the whole team and the whole operation unit under the same circumstances. It is necessary to mobilize the enthusiasm of team members as much as possible, and gradually establish a positive team atmosphere, which is significantly beneficial for the improvement of staff skills.

(2) Implement fault classification and reduce the labor cost of fault handling. On the basis of optimizing team management, we can carry out fault classification and grading, and then deal with it by the technical backbone or ordinary staff in the corresponding team, so as to ensure that a small number of technical backbones can be applied to the most complex and difficult faults, reduce the human cost factors of such faults, and help to form a good learning atmosphere in the team.

(3) Moderately reduce the standards for the purchase of tools and instruments, and advocate taking measures according to local conditions. For the occasions with high requirements for train operation and passenger flow. For example, for the maintenance, there is a requirement for tightening torque of the fastening bolts of the sliding doors on platform. In the actual maintenance in procedure, the team members will use the torque wrench to correct it. As it is related to driving safety, it is unacceptable to consider the risk of passenger injury caused by the failure of sliding door due to the deviation of tightening torque during operation. So in this respect, it is suggested to employ tools with low error, better stability and high price. However, in most fields of application, such as the verification test on the solenoid valve of the start device of Fire Alarm System (FAS) gas quenching system, the start

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voltage of the operative solenoid valve is required to be DC24V. In fact, the standby voltage under normal circumstances is DC10V. The voltage gap between the two is large. At present, the main parameter configuration products on the market can be employed in this regard, and reasonable competition in the market can be introduced to reduce the procurement cost to the greatest extent. In this way, the delivery cycle can be greatly accelerated, the requirements of later inspection and calibration are low, and the use burden of team members is correspondingly low.

(4) Carry out equipment generalization and improve the usage rate of spare parts. First of all, we should start with simple electrical components, carry out in sequence from simple level to difficult level, and from ordinary miniature circuit breakers, AC contactors, intermediate relays, molded case circuit breakers, etc. on account that a great number of lines make them more faults correspondingly.

(5) Mobilize the majority of team members to repair the faulty equipment independently to reduce the dependence on the manufacturer. For the faulty spare parts that have been replaced, the current practice is generally the unified scrap treatment, which is recycled by the scrap recycling unit at the scrap price. Compared with the purchase price of spare parts, there is a huge difference, but it is likely that there is still residual value to be used. For example, the power module of FAS local control box is composed of purchased switching power module and power supply detection module. If the switching power module with same parameters is replaced, the main power alarm will be caused because there is no power supply detection module. After disassembly research, it is found that the power supply detection module is welded on the output end of switching power supply, and then it will be welded on the same-parameter switching power of different brands after disassembly. The source is installed in the local control box of FAS gas quenching, without alarm, it can be matched. After big data analysis between the year 2013 and 2015, the failure rate of power supply detection module accounts for 17% of the switching power supply, which is much lower than the switching power supply module, so it can be reused. From the year 2016 to 2019, our company purchased this switching power supply with general parameters alone, which saved more than 200,000 yuan of procurement funds compared with the purchase of power modules from the original factory. If the equipment that has been transformed by the manufacturer can be disassembled and analyzed, the general equipment in the current market can be used to the greatest extent, the dependence on the original plant would decline and the procurement cost can be effectively reduced, meanwhile, the skill level of team members can be trained and improved.

(6) Strengthen the voice of technical personnel in the bidding process, and implement the assessment mechanism for suppliers. In most of the existing bidding procedures, the bid evaluation personnel grade the bidding price according to the established formula, and in the environment of relative communication shielding, they are not familiar with the specifications and models of some non-professional equipment spare parts, so they cannot make timely and accurate judgment in the first time. The bidder can be required to provide detailed technical parameters of relevant bidding spare parts, appropriately expand the proportion of technical scores, guide the bidder out of the old thinking of winning the bid at the lowest price, strengthen the assessment of suppliers after the end of the supply period, warn and deal with suppliers with poor business conduct, and establish a blacklist system [6].

(7) Quantify the quota measures, and timely formulate and implement the quota system. At the initial stage of operation of electromechanical equipment of rail transit, due to the unfamiliarity with the new equipment, it may lead to the inaccuracy of the quota materials for maintenance (including the quota for use of spare parts, the quota for tools and instruments, and the quota for consumption). However, after certain operation and maintenance, quantitative quota measures must be formulated in time and improved in the subsequent maintenance, so as to ensure the safe and stable operation of the equipment. Considering this point, the usage of quota should be minimized. In this way, the material cost can be effectively controlled.

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4. Conclusion

The optimization and practice of reducing the maintenance cost of electromechanical equipment in urban rail transit is an important part of "cost reduction" for rail transit operation. In the case that the current "expansion" of urban rail transit cannot achieve the expected purpose, "cost reduction" is particularly important. For each operation unit, the operation cost can be reduced. For the team members of the majority of operation units, self-worth can be realized. For urban rail transit industry in China, it can promote its high quality development, so as to realize the optimal allocation of resources, and better serve the travel of the masses.

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