

Construction of Lean Management System for Power Grid Equipment Based on Multi-Service Convergence

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Abstract. As one of the most important components of power grid, the reliability of the equipment plays an important role in both safe stability of power grid and the improvement of the customer's electricity environment, which matters the economic benefits of all sides. In this paper, the lean management system of power grid equipment based on multi-service convergence is relied on the whole process of technical supervision. Through applying the management system, it can realize the scientific upgrading of the lean management level of power grid equipment.

1. Introduction

The reliability of electrical equipment has been paid more attention than ever with the continuous improvement of the power grid's impact on daily lives, social stability and national security [1]. Furthermore, the quality of equipment is an important factor in the brand image of the power company's security, quality, efficiency, and service level. In order to enhance the intrinsic safety of equipment and ensure the stable operation of power grid, it is imperative to establish a life-cycle management system for electrical equipment.

2. System connotation and design principles

2.1. Connotation

Lean management system for power grid equipment based on multi-service convergence is a system composed of 10 stages [2], with multiple service convergence involved. The system is characterized by many stages and complex business. Thus, a scientific and effective management system has been established through the means of taking the whole process of technical supervision as the main line, focusing on the supervision of the equipment quality and the acceptance of completion, grasping the quality analysis of equipment defects and integrating of a number of professional fields.

2.2. Design principles

Lean management system for power grid equipment based on multi-service convergence is an important access to the technical supervision of the whole process of power grid equipment and to improve the safe and stable operation of the power grid. Therefore, it is necessary to establish a



scientific, reasonable and practicable management system [3], which should abide by the following principles:

2.2.1. Wholeness. The lean management of the whole life cycle of power grid equipment is fully controlled.

2.2.2. Universal property. The lean management system has a promoting effect on communication and coordination and the system needs to be applicable to various types of equipment, every stage and the management of various services.

2.2.3. Flexibility. The lean management system should have the ability to extend and customize.

3. Organization of the Text

3.1. Design idea

3.1.1. Make the scope clear. The management of power grid equipment contains 10 stages, including planning research, engineering design, equipment procurement, equipment manufacturing, equipment acceptance, equipment installation, equipment commissioning, completion acceptance, operation and maintenance and retirement. At the same time it involves development, transportation inspection, infrastructure, materials and many other services.

3.1.2. Make the mode clear. With the method of target management [4], a lean management system for power grid equipment is established. The management system is a hierarchical and multi-service integration system. From top to bottom, the system is as follows.

- a. Equipment Status Evaluation Center of the Electric Power Research Institute (hereinafter referred to as Evaluation Center).
- b. City power supply company (Maintenance Company, power transmission engineering company).
- c. Strategy department, materials department, construction department, maintenance and repair department, maintenance department, substation maintenance department and technical economics research department.

3.1.3. Make the goal clear. The 10 stages and multiple services involved in power grid equipment will be fully managed [5]. Evaluation Center masters the health status of the whole life cycle of the equipment. According to the status of the equipment, the strategy and measures are formulated. Thus, Evaluation Center completes the goal of improving the lean management level of power grid equipment and realizes the orderly operation of the power grid.

3.2. Establishment

The construction of the management system takes the whole process of technical supervision as the main line. The various stages and services of the equipment should be organically integrated and managed together. First, the lean management of power grid equipment is decomposed by layers. Then, the information of each management layer is reported from bottom to top. Finally, Evaluation Center is responsible for making the decisions. After considering the specific situation and analyzing the results, scientific decisions are made by Evaluation Center. By then, the goal of the lean management of power grid is realized. The framework of the system is shown in Figure 1. The number 1 in the framework indicates that the work in planning research is completed by operation and maintenance with strategy. The number 2 in the framework indicates that the work in Equipment acceptance is completed by operation and maintenance with materials. The number 3 in the framework indicates that the work in completion acceptance is completed by operation and maintenance with construction. The number 4 in the framework indicates that the work in completion acceptance is completed by operation and maintenance with construction.

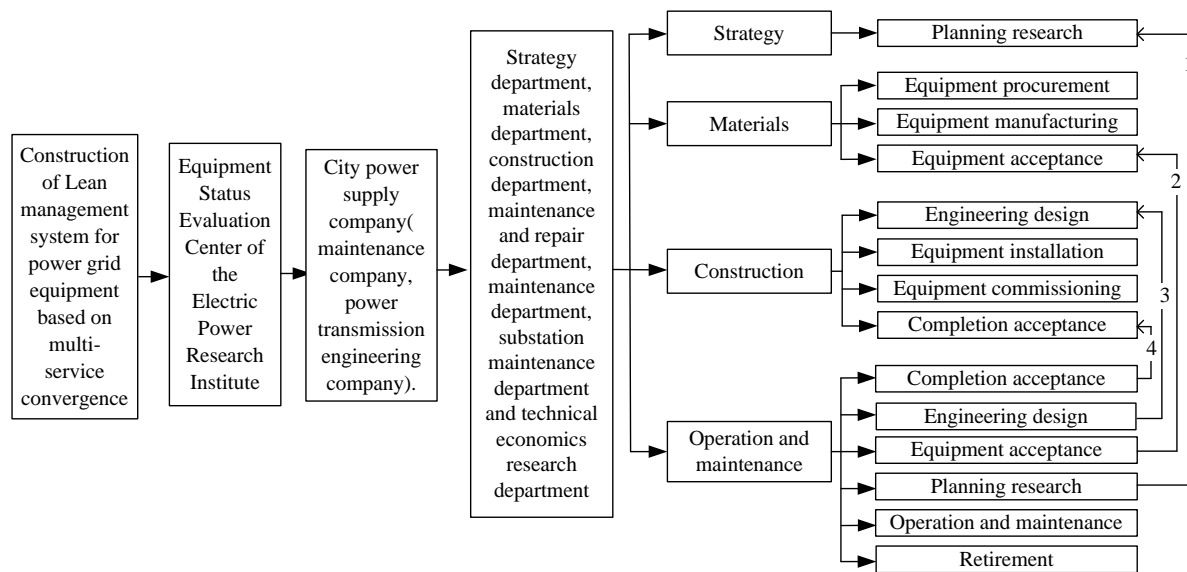


Figure 1. The framework of the system

4. Approaches of system implementation

4.1. Planning research and engineering design stages

Evaluation Center organizes professional and technical personnel of city power supply company (Maintenance Company, power transmission engineering company) to participate in the review conference for research and design. Meanwhile, experts from the Evaluation Center are also involved. For the problems with power grid equipment, Evaluation Center is responsible for putting forward practical solutions from the perspective of management and technology.

4.2. Equipment procurement stage

Evaluation Center organizes professional and technical personnel to participate in formulating technical specifications for bidding. According to the actual situation and actual demand, special technical parameters will be put forward.

4.3. Equipment manufacturing and equipment acceptance stages

When the equipment is in the manufacturing plant, Evaluation Center organizes professional and technical personnel to take part in the testimony of key nodes. The personnel should consult with manufacturers and put forward a solution in view of the existing problems. When the equipment is leaving the manufacturing plant, Evaluation Center organizes and coordinate qualified feeler mechanism to complete the testing work. The tested equipment include distribution transformers, switch gear, power cables, accumulators, insulator strings, 10kV isolating switch and fuses. The test projects include electrical performance and metal performance tests. At the same time, Evaluation Center supervises professionals.

4.4. Completion acceptance stage

Evaluation Center organizes the relevant professional and technical personnel to examine the test reports of the equipment. The equipment include transformers (reactors), switches, four small devices, grounding grids, etc. The experts from Evaluation Center communicate with testers at the same time. After the test report is approved, Evaluation Center organizes the professional and technical personnel to check the project site. The contents of the inspection include equipment installation and equipment commissioning. Considering the inspection results and actual situation, the suggestions whether the equipment meets the conditions of delivery is put forward.

4.5. Operation and maintenance stage

Evaluation Center fully controls the operation and abnormal situation of the power grid equipment through the PMS system. Evaluation Center regularly evaluates the health status of the equipment. According to the evaluation results, effective maintenance strategy will be formulated. Evaluation Center releases the alarm list for the abnormal equipment. Based on the degrees of anomaly, the abnormal equipment gets whether site treatment or returned to the plant. For the equipment returned to the plant, Evaluation Center organizes the equipment ownership unit and the equipment manufacturer to investigate the abnormal reasons. Finally, suggestions given to reduce the probability of similar anomalies are put forward.

4.6. Retirement stage

City power supply company (Maintenance Company, power transmission engineering company) needs to complete the approval process internally and submits complete approval procedures and declares according to the corresponding process. All materials and procedures are audited by Evaluation Center. The power grid equipment is allowed to be discarded after there is no problem.

5. Application example and effect

In order to explore the practical application of lean management system for power grid equipment based on multi-service convergence, a 220kV transformer is taken as an example in this paper.

5.1. Example

5.1.1. Planning research and engineering design stages. Evaluation Center shall organize professional and technical personnel to make suggestions in the review conference for research and design meeting. Examples of suggestions are as follows. Transformers with on load voltage regulation should be selected instead of no load regulation. Large capacity transformers should be used in terms of the long-term load. The transformer capacity should be 180MVA and above, not 120MVA. For variable ratios, 220/69 x (1 + 8 x 1.25%) or 230/66 x (1 + 8 x 1.25%) is prohibited and 220/66 x (1 + 8 x 1.25%) or 230/69 x (1 + 8 x 1.25%) should be used.

5.1.2. Equipment procurement stage. Evaluation Center organizes professional and technical personnel to participate in formulating technical specifications for bidding. For example, A gas relay with a double floating ball structure instead of a single node should be put forward in the technical specification.

5.1.3. Equipment manufacturing and equipment acceptance stages. Evaluation Center organizes technical personnel to witness the key nodes in the manufacturing plant, such as the superposition of silicon steel sheet, winding coil and factory test. If the display time of the insulation oil is not up to standard, the results of the partial discharge test will exceed the standard. At this point, manufacturers are required to display the insulation oil for sufficient time.

5.1.4. Equipment installation and Equipment commissioning stages. The professional and technical personnel of Evaluation Center witness the key nodes of on-site installation and commissioning. According to actual situation, requirements and suggestions are put forward. Examples of suggestions are as follows. The bushing oil level observation window should be oriented towards the inspection channel instead of facing the firewall. The fastening screws connecting the cooling device and the body should be tightened with torque wrench.

5.1.5. Completion acceptance stage. Evaluation Center organizes technical personnel to verify the test reports of the transformer. Audited projects include routine test, handover test, transformer insulation oil, core grounding current monitoring device and on-line monitoring device for oil chromatography.

After the examination and approval, Evaluation Center organizes the inspection personnel to cooperate with the construction personnel to check the site. In order to achieve zero defect operation of the equipment, corrective measures are put forward according to the problems existing on the site. For example, the transformer leaks oil, the silica gel of the humidifier is discoloration, the iron core piece of ground copper card is not painted yellow and green.

5.1.6. Operation and maintenance stages. According to the defect level (general, serious and dangerous), the blackout plan and countermeasures should be put forward when the transformer in operation is abnormal. When the transformer needs to return to the plant to find out the cause of the anomaly, the professional and technical personnel will be organized by Evaluation Center to the factory. According to the transformer health status (normal, abnormal, attention, serious), solutions and corresponding maintenance strategies are formulated. Evaluation Center gives technical support for the problems found in maintenance.

5.1.7. Retirement stage. The transformer for retirement application will be given the appraisal opinion by the Evaluation Center. After approval, the property rights unit of the transformer shall submit materials and retire according to the process.

5.2. Effect

5.2.1. The quality of the product has been greatly improved. Through the application of the lean management system, the quality of the transformer can be evaluated and the problems of the quality can be found directly. Then the results can be fed back to the manufacturers so that the quality of products is continuously improved.

5.2.2. The level of management has been significantly improved. Through the construction of the system, the whole life cycle management method of transformer is more detailed. Therefore, the rationalization, standardization and standardization of all stages of transformer management are realized.

5.2.3. Actively respond to the company's call. The Lean management system responds to the call for the promotion of *the Implementation Rules of Lean Technology in the Whole Process*. The construction of the system is based on the whole process of technical supervision. The goal of lean management of power grid equipment has been realized. At the same time, it also deepens the concept of technical supervision in the whole process of power grid equipment. The whole process of technical supervision has been pushed to a higher level.

6. Conclusion

Through the use of lean management system, the management of power grid equipment has achieved remarkable progress. Lean management level has been steadily improved by building a unified and open management model, formulating a scientific and standardized management pattern, establishing comprehensive and efficient management measures. Besides, the system provides a more standardized implementation plan and more detailed implementation measures for lean management of power grid equipment. At the same time, considerable economic and social benefits have been generated. In the end, the lean management system ensures the safe, stable and reliable operation of the power grid.

7. References

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