Research on operation and maintenance cost of power grid equipment based on standard operation-taking 220kV transformer substation as an example

Xuefei Zhang[1], Zhiwei Li [1], Chengzhi Wang [2], Xuejun Tang [1], Sen Yang [3*]

[1]State Grid Hubei Economic Research Institute, Technology and Economic Center，Wuhan, Hubei
[2]State Grid Hubei Electric Power Co., Ltd. Wuhan, Hubei
[3]Central China Technology Development Co., Ltd. Wuhan, Hubei

Abstract: In view of the inadequate implementation of the grid operation and maintenance standards and specifications current, the lack of planning in cost usage, and the inability to achieve single equipment collection of costs, taking 220kV substation as an example, this paper proposes a single asset operation and maintenance cost calculation method based on grid standard operations, and puts forward suggestions on the cost management of grid equipment operation and maintenance. Through verification and analysis with the relevant provisions of the cost supervision and examination method, the power grid company will face greater operating pressure, and the cost management level needs to be further improved. Through the calculation of the operation and maintenance cost of a single asset, it provides a reference basis for the distribution of the operation and maintenance cost of the power grid enterprise, and at the same time provides a reasonable explanation for the power grid enterprise to adapt to the cost supervision and review of the transportation dispatching pricing.

1 Introduction

In recent years, the social macro-economy has slowed down, the growth rate of electricity has slowed down, and the space for electricity prices has narrowed. Under these circumstances, the state has continued to introduce phased policies to limit the reduction of electricity costs. Affected by multiple profit reduction factors and uncertain factors, the profitability of power grid companies has dropped significantly, the operating pressure is unprecedented. On January 19, 2020, the National Development and Reform Commission officially issued the "Provincial Grid Transmission and Distribution Price Pricing Measures" to strengthen reasonable constraints, refine the scope of price verification, and optimize the structure of electricity prices. The pricing method pointed out that the total of the three items of new material costs, repair costs and labor costs during the regulatory cycle shall be determined at no more than 2% of the original value of the new transmission and distribution fixed assets during the regulatory cycle. Therefore, higher requirements have been put forward for the audit of the cost of power transmission and transformation operation and maintenance for power grid enterprises. In addition, with the gradual improvement of State Grid's multi-dimensional lean management system, State Grid's requirements for cost collection have increased significantly. However, due to the lack of a standard cost system for power grid operation and maintenance, the degree of refined cost control is insufficient. The operation and maintenance cost of single equipment is difficult to collect, which leads to the inaccuracy of the operation and maintenance cost in the permitted cost. Therefore, based on the standard operation of the power grid, it is necessary to check the standard consumption level of the asset operation and maintenance cost of the listed items, explore the inherent contradictions of equipment management, and promote the deep integration of industry and finance.

2 Analysis of the current situation of the cost management of the operation and maintenance of power grid equipment

Through combing and analyzing the assets from PMS2.0 and ERP2.0 system and cost data of the power grid company, selecting three prefecture and city companies under a certain power grid company to conduct field investigations and in-depth interviews. Therefore, it is concluded several management issues from different aspects which towards the operation and maintenance cost of power grid equipment.

*Corresponding author:13120686308@163.com

2.1 The implementation of operation and maintenance standards and specifications is not comprehensive

The operation and maintenance of power grid equipment has a series of management regulations and maintenance standards, such as the standard operation database of power grid operation and maintenance, but in the daily operation and maintenance work, there is still a phenomenon that the implementation of standards and specifications is not comprehensive. First, when the operation and maintenance personnel carry out daily maintenance work, they rely to a large extent on their previous work experience to subjectively judge whether electric equipment needs to be overhauled, and there is a phenomenon that should be checked but not checked. Second, in the process of overhaul, there is a problem of non-standard work task management. Through field research, the grid operation and maintenance work tickets are filled randomly, and the content of the work cannot be tracked reasonably. In addition, the operation and maintenance costs are packaged in multiple assets account during financial accounting which could not be summarized into a single asset account.

2.2 Lack of planning for the cost of operation and maintenance

Based on the grass-roots survey, the grid operation and maintenance work exist the phenomenon of lack a comprehensive plan, the annual maintenance cost expenditure plan has not been formulated in advance, the operation and maintenance work has not achieved actual results, and the heavy fault maintenance and light routine maintenance. The reduction in the cost of operation and maintenance of state equipment to ensure the reliable operation of main equipment will bring more hidden dangers to the overall operation of the power grid in the long term, and even cause "sick operation" of local equipment.

2.3 The cost accounting system for operation and maintenance is not sound

Although the current operation and maintenance cost accounting system has classified different types of costs, the organizational structure is the main line, and the county-level power supply company is used as the unit for cost collection. However, this kind of cost collection method still cannot meet the current cost usage control and equipment lean management requirements. First, the operation and maintenance materials of prefectural and municipal companies are purchased through supermarket-based platforms. When operation and maintenance operations occur, the team members use the materials, resulting in material costs that cannot match the specific operation items. Second, when the maintenance operations were outsourced, the maintenance tasks of different stations and lines and different equipment were packaged and outsourced in batches, and the corresponding costs were not integrated into the corresponding equipment assets during the cost expenditure. Due to the unsound cost accounting system, the expenditure of operation and maintenance cannot be refined management, and the collection and statistics of different voltage levels and equipment asset costs cannot be realized.

3 Significance of establishing standard cost for operation and maintenance of power grid equipment

3.1 Systematic control and full understanding of the status quo of the use of cost funds for power grid enterprises

At present, the operation and maintenance cost management methods of various power grid companies are relatively extensive. The finance department calculates and budgets according to the number of substations, and the municipal companies use them independently. The relevant departments lack process management and supervision of the use of operation and maintenance costs for each company. By analyzing current status of the use of power grid operation and maintenance costs, truly presenting the cost composition, helping power grid companies understand the capital use of grassroots units, and promoting standardized management of the use of operation and maintenance costs.

3.2 Provide a reference basis for the release of operation and maintenance costs

With the development of power grid enterprises, problems such as low-cost management and disconnection between business management and cost control have become increasingly prominent, which extensive cost management is difficult to solve the above problems. Therefore, it is necessary to establish a standard operation-based power grid equipment operation and maintenance cost management system to carry out refined management towards the power grid operation and maintenance costs. Through reasonable calculation of the cost of operation and maintenance of a single substation, the cost management of operation and maintenance will be transformed from the single control of the financial department to the integrated management and control method of industry and finance, improve the cost management of power grid operation and maintenance, improve the quality of operation and maintenance, and ensure the safety of power grid equipment stable operation.

3.3 Provide reasonable explanations for grid companies to adapt to the supervision and review of transmission and distribution pricing

The strict verification of the cost of power grid enterprises by the state is reflected in the further strengthening of supervision, accurately verifying electricity prices, clearing regulatory blind areas, verifying unreasonable costs, and verifying reasonable profits, thereby further

reducing the level of electricity prices. At present, the operation and maintenance cost management of power grid enterprises are relatively extensive, and the process of fund use lacks reasonable material support. In the strict cost supervision and examination of electricity transmission and distribution price, the operation and maintenance cost may be reduced. This study is helpful to establish a scientific and reasonable cost pricing mechanism, form a cost standard of operation and maintenance, and provide a reference basis for judging the authenticity and rationality of operation and maintenance costs of power grid enterprises. It is helpful for power grid enterprises to adapt to the cost supervision and examination requirements of transmission and distribution price.

4 Standard Cost Estimation of Power Grid Operation and Maintenance Based on Standard Operation

4.1 Design ideas

Firstly, based on the original standard operation database, subdivided by asset category level by level, sort out all the equipment assets and corresponding maintenance operations of a single 220kV substation to form a substation standard operation database. Secondly, refer to the grid maintenance project budget quota and standard operation database to determine the cost of individual maintenance operations of the substation, including labor costs, material costs, machinery costs, etc., thereby obtaining the individual operation costs of all substation operations. Thirdly, consider the number of various equipment in the substation, the annual frequency of maintenance operations, and combine the cost of individual operations to calculate the annual operational cost of substation maintenance. Finally, comprehensively analyzing the ratio of self-support and outsourcing of substation maintenance, constructing a theoretical cost model of substation maintenance.

4.2 Standard operating level cost combing

Taking a single substation as the starting point, sort out all the maintenance work items involved in the substation and the operation cost of a single operation, and use this as the basis for the theoretical maintenance cost estimation of the substation.

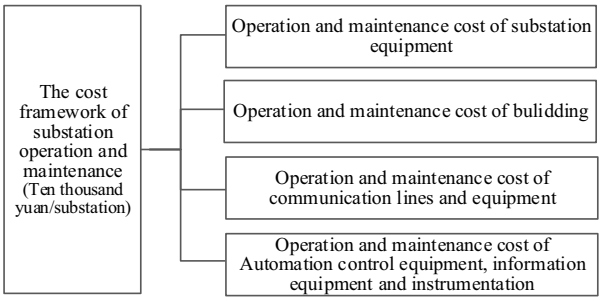

Figure 1. The cost framework of substation operation and maintenance

4.2.1 Sorting out substation assets

Substation assets are divided into 4 major categories, 9 medium categories, and 69 small asset categories according to categories. Among them, the major asset categories of assets include substation equipment, buildings, communication lines and equipment, automation control equipment and information equipment, and instrumentation. The middle asset categories include transformers, electrical general equipment, converter equipment, power cables, communication equipment, other production buildings, relay protection and safety automatic devices, instrumentation and testing equipment, and automation systems and equipment. The small asset categories include 69 types of assets, such as main transformers, grounding transformers, circuit breakers, lightning rods, low-frequency load shedding devices.

Table1. List of substation and substation equipment assets combing

Major asset categories	Medium asset categories	Small asset categories
substation equipment	transformers	grounding transformer, transformer used, main transformer
	power cables	in-station power cable
	electrical general equipment	lightning arresters, wall bushings, power capacitors, current transformers, voltage transformers, circuit breakers, load switches, isolating switches, closing coils, grounding resistance, insulators, switch cabinets, bus bars, fuses, arc suppression devices, combined electrical appliances, combination transformer
	converter equipment	reactor
buildings	other production buildings	grounding grid
communication lines and equipment	communication equipment	AC power distribution panel, coupling capacitor, battery

Major asset categories	Medium asset categories	Small asset categories
automation control equipment and information equipment, and instrumentation	relay protection and safety automatic devices	protection management machine, protection information management system, backup power automatic switching device, transformer protection, measurement and control device, charger screen, low-frequency load shedding device, low-voltage load shedding device, arc protection, capacitor protection, short lead protection...
	instrumentation and testing equipment	battery detection device
	automation systems and equipment.	substation monitoring system, secondary safety protection, wide-area phasor measurement system, clock synchronization device, remote control terminal equipment (RTU)

4.2.2 Sorting out the cost of a single operation of a substation

Based on sorting out substation assets, combined with the calculation scope of maintenance cost, further sort out the operation and maintenance work items involved in each asset. After sorting out, the total amount of the operations of 220kV substations is 311 items, which refer to the "Budget Quota for Grid Maintenance Projects" (2015 Edition) issued by the National Energy Administration to further sort out the cost of each individual operation for the maintenance of all equipment in the substation. Since the standard operation items of the substation based on the standard operation database are not completely matched with the "Power Grid Maintenance Project Budget Quota". Therefore, in the matching of the cost of a single operation, the cost of a single operation that cannot be fully matched which supplemented by the cost data of a single operation in the grassroots survey. Sort out the labor cost, material cost, and mechanical cost corresponding to the various standard operations of the substation. Taking the main transformer as an example, the cost of each individual operation is as follows:

Table2. Single standard operating cost of main transformer in substation (unit: yuan)

standard operation name	contents of operation	labor cost	material cost	machinery cost	total
main transformer neutral point equipment maintenance	main transformer neutral point equipment maintenance	62716.17	5589.25	1597.5	69902.92
routine test of main transformer	routine test of main transformer	39184.18	38.46	67956.11	107178.75
maintenance of the main transformer cooling device control box	maintenance of the main transformer cooling device control box	2626.81	254.92	138	3019.73
main transformer bushing oil supplement and heat treatment	main transformer bushing oil supplement and heat treatment	4626.81	310.44	159.5	5096.75
main transformer live detection test	main transformer live detection test	0	29.1	1767.4	1796.5
routine comprehensive maintenance of main transformer	main transformer parts replacement, defect treatment, minor repair	22340.08	2024.42	8331.24	32695.74
maintenance of the strong oil circulating cooling device of the main transformer	maintenance of the strong oil circulating cooling device of the main transformer	17896.5	11582.82	1433	30912.32
main transformer radiator overhaul	main transformer radiator overhaul	6546.45	6000.43	138	12684.88
maintenance of no-load tap changer of main transformer	maintenance of no-load tap changer of main transformer	2707.17	9.28	132	2848.45
maintenance of on-load tap changer of main transformer	maintenance of on-load tap changer of main transformer	2466.09	6.43	132	2604.52
main transformer body adjusts the oil level	main transformer body adjusts the oil level	9028.61	23285.64	568.67	32882.92
chromatographic analysis of main transformer oil	chromatographic analysis of main transformer oil	1639.34	38.32	292.63	1970.29
treatment of oil leakage defect of main transformer	treatment of oil leakage defect of main transformer	2185.79	488.07	132	2805.86

standard operation name	contents of operation	labor cost	material cost	machinery cost	total
main transformer diagnostic test	main transformer diagnostic test	19326.9	38.46	23164.35	42529.71
elimination of online oil filter device for main transformer	replace the main transformer oil pump and filter element	223.2	25.23	150.9	399.33
main transformer oil conservator maintenance	main transformer oil conservator maintenance	222.78	65.77	235.2	523.75

4.3 Basic data processing of substation maintenance cost standard estimation

After sorting out the cost of individual substation operations above, it is necessary to deal with the number of substation equipment, annual operating frequency of individual operations, outsourcing and non-outsourcing, etc., to calculate the overall operation and maintenance costs of the substation.

4.3.1 Number of substation equipment

The number of the same equipment in the substation includes multiple ones, the total operation and maintenance cost needs to consider all the equipment, and the number of equipment must be multiplied by the single operating equipment. The quantity of substation equipment, selected from the average value of 220kV substation equipment in the province, is 207. And then the quantity of equipment is revised with reference to the "General Design of Power Transmission and Transformation Engineering of State Grid Corporation" (220kV substation modular construction) and the inventory of actual substation assets.

4.3.2 Annual frequency of single operation

Firstly, for planned overhaul operations, there are generally fixed overhaul time and period. According to the fixed overhaul period, the annual overhaul frequency can be estimated. Secondly, for unplanned overhaul, which is no frequency operation items, through the following ways to solve: First, according to the defect records of 220kV substations across the province, the frequency of defect elimination of equipment could be counted. Second, referring to the historical experience data obtained by the grassroots survey to obtain the annual operating frequency of some maintenance operations based on the professional responsibility of grassroots operation and maintenance and the experience judgments of relevant experts. Final, referring to the maintenance rules of the "General Management Regulations on Power Substation Maintenance of the State Grid Corporation of China", corresponding regulations have been made for the equipment maintenance cycle of the C-type maintenance of routine inspections and tests, which shall be regarded as the annual operation frequency of a single operation.

4.3.3 Self-operated and outsourced maintenance cost processing

In addition to the self-employed maintenance of substation operation and maintenance work, part of the work is outsourced to external units for maintenance through direct outsourcing. The impact of outsourcing and non-outsourcing (i.e., self-operating) on the cost calculation of substation operation and maintenance is mainly in labor costs. Self-operated maintenance work is performed by the internal personnel of the company, and the labor cost is calculated in the labor salary, and the operation and maintenance cost are not repeatedly calculated. The work items sorted out through the standard operation database include labor costs, material costs, and machinery costs. The entire cost of outsourcing and self-support is not considered. Therefore, the calculation of the self-operated part of the maintenance cost should be based on the standard operating cost calculation which needs to exclude labor costs.

The overall operation and maintenance costs of substations are calculated in a proportionally weighted manner of outsourcing and self-operating. The ratio of outsourcing and self-operated maintenance costs is determined with the historical data. According to statistics, in 2018, the total power grid maintenance costs of provincial companies, including maintenance fees and material costs, were 509040 ten thousand yuan, of which outsourced maintenance costs were 351054 ten thousand yuan, outsourced materials costs were 2597 ten thousand yuan, and self-operated materials costs were 155389 ten thousand yuan. It can be calculated the proportion of outsourcing power grid maintenance

$$\text{the proportion of outsourcing power grid maintenance} = 100\% \times (351054 + 2597)/509040 = 69.47\%; \quad (1)$$

$$\text{the proportion of self-supporting power grid maintenance} = 100\% \times 155389/509040 = 30.53\%. \quad (2)$$

When calculating the maintenance cost of a single substation, the theoretical maintenance cost of a single substation can be calculated according to the following formula based on the ratio of self-support and outsourcing of the power grid maintenance:

$$\text{Maintenance cost of a single substation} = \text{self-operated expenses} + \text{outsourcing expenses} = \sum (\text{Individual operating material cost} \times \text{annual operating frequency} \times \text{equipment quantity}) \times \text{self-operated ratio} + \sum [(\text{Material cost for single operation} + \text{labor cost for single operation} + \text{mechanical cost for}$$

single operation) × annual frequency of operation × number of equipment] × outsourcing ratio
=∑ (Individual operation material cost × annual operation frequency × equipment quantity)×30.53%+∑[(Material cost for single operation + labor cost for single operation + mechanical cost for single operation) × annual frequency of operation × number of equipment]×69.47% *(3)*

4.4 Cost calculation of substation operation and maintenance

After completing the substation equipment asset type, equipment quantity, frequency of single operation maintenance, labor cost, material cost, mechanical cost corresponding to a single operation, and the proportion of substation maintenance self-support and outsourcing, the cost of substation operation and maintenance can be calculated.

the total cost of substation operation and maintenance = substation equipment operation and maintenance cost + building operation and maintenance cost + communication line and equipment operation and maintenance cost + automation control equipment, information equipment and instrumentation operation and maintenance costs. *(4)*

Considering the two cases of all outsourcing and all self-operating maintenance respectively, the outsourcing cost and self-operating cost of substation equipment maintenance can be calculated in the two cases.

Table3. Total cost of outsourcing and self-operating operation and maintenance of substation equipment and transformer assets (unit: yuan)

asset categories	small asset categories	fully self-support	outsourcing	total theoretical cost
substation equipment	main transformer	24125.90	150159.50	111686.64
	transformer used	531.7312	3506.503	2598.428
	grounding transformer	428.502	3097.502	2282.766
total		25086.13	156763.51	116567.83

4.4.1 Overhaul costs of substation equipment and transformers under all outsourcing

Assume that the 30 standard operations corresponding to the transformer are all outsourced maintenance, it can be calculated that the total cost of overhauling the substation equipment in the substation for one year is 156763.51 yuan. The specific calculation process takes the first main transformer neutral point equipment maintenance as an example.

The standard operation cost of this item = 0.2×2×(62716.17+5589.25+1597.5) =27961.17 yuan *(5)*

The other single operation costs can be calculated by analogy. It is calculated that the total cost of outsourcing operation and maintenance for the main transformer of the substation equipment is 136320.1 yuan, the total cost of the corresponding maintenance outsourcing for the transformer used in the substation equipment is 3506.5 yuan, and the total cost of the corresponding maintenance outsourcing for the grounding transformer of the substation equipment is 3097.50 yuan.

4.4.2 Overhaul costs of substation equipment and transformers under all self-operated conditions

Assume that the 30 standard operations corresponding to the transformer are all self-operated maintenance, it can be calculated that the total cost of overhauling the electrical equipment in the substation for one year is 25086.13 yuan. The specific calculation process takes the first item of main transformer neutral point equipment maintenance as an example.

The standard operating cost of this item = 0.2×2×5589.25=2235.70 yuan *(6)*

The other individual operating costs can be calculated by analogy. It is estimated that the total self-operated maintenance cost for the main transformer of the substation equipment is 24125.90 yuan, the total cost of the outsourcing maintenance for the transformer used in the substation equipment is 531.73 yuan, and the total cost of the corresponding maintenance outsourcing for the grounding transformer of the substation equipment is 428.5 yuan.

4.4.3 Considering the proportion of self-operated and outsourced substation equipment and transformer maintenance costs

According to the proportion of outsourcing in the power grid maintenance process accounting for 69.47%, and the proportion of self-operating accounting for 30.35%, it can be calculated the maintenance cost of substation transformer equipment.

the maintenance cost of substation transformer equipment=156763.51×69.47%+25086.13×30.35%=103312.5 yuan. *(7)*

In the same way, according to this method, the corresponding theoretical costs of other assets could be calculated, and the calculation results are detailed in the table below.

Table4. Standard cost of 220kV substation operation and maintenance (unit: yuan)

major asset categories	total outsourcing cost	total self-support costs	theoretical cost
substation equipment	1324803.26	166999.45	971373.47
buildings	445.75	93.84	338.32
communication lines and equipment	19815.42	231.55	13837.27
automation control equipment, information equipment and instrumentation	536782.83	31217.18	383454.47
total	1881904.03	198548.77	1368045.04

The total cost of outsourced maintenance for building assets is 445.75 yuan, and all self-operated maintenance costs are 93.84 yuan. After considering the proportion of outsourcing and self-operating, the theoretical operation and maintenance cost is 338.32 yuan; communication lines and equipment assets correspond to all outsourcing which the maintenance cost is 19815.42 yuan, and the total self-operated maintenance cost is 231.55 yuan. After considering the proportion of outsourcing and self-operation, the theoretical operation and maintenance cost is 13837.27 yuan; automation control equipment, information equipment and instrumentation assets correspond to all outsourcing maintenance costs is 536782.83 yuan, and the total self-operated maintenance cost is 31217.18 yuan. After considering the proportion of outsourcing and self-operating, the theoretical operation and maintenance cost is 359210.93 yuan. As a result, it is finally calculated that the total theoretical total cost of overhaul for a year of 220kV substation is 136.80 ten thousand yuan.

5 Analysis of the results of standard cost calculation for power grid operation and maintenance

According to the requirements of the cost supervision and review of the reform of the power transmission and distribution price in the previous regulatory cycle, the new material cost and the new repair cost accounted for no more than 2.5% of the original value of the new fixed assets, and the original value of the fixed assets of the 220kV substation of the provincial company was about 6500 ten thousand yuan on average. Divide the sum of the calculated material cost and repair cost by the original value of the fixed assets of the substation to get the sum of the material cost and repair cost of the 220kV substation accounted for 2.1% of the original value of the fixed assets, which did not exceed the 2.5% limit of cost supervision and examination which satisfies the requirements for cost supervision. However, from the trend of transmission and distribution price reforms, the National Development and Reform Commission issued a new "Provincial Grid Transmission and Distribution Price Pricing Measures" in January 2020, stipulating that the total of three new materials costs, repair costs, and labor costs shall not exceed 2% of the original value of the supplementary fixed assets, and the cost control is more stringent. According to this standard, power grid companies will face greater operating pressure, and the cost management level needs to be further improved. However, the estimated material costs and repair costs are accumulated based on the work items that should be incurred in the full operation and maintenance. It may happen that the inspections are not inspected, and they are mostly used for emergency inspections. There are no sufficient funds for advance planning, prevention, or resolution of hidden dangers, which will bring greater hidden dangers to the safe and stable operation of the power grid. Therefore, this topic is based on the cost of full production, operation and maintenance, and the power grid adapts to the supervision and review of the cost of transmission and distribution pricing to provide a reasonable explanation.

6 Conclusion

Although the standard cost calculation system for operation and maintenance of power grid equipment does not strictly belong to the industry standard, it is based on the actual operating data basis and the standard operating database in operation, through field investigations, and integrates various business activities of the substation. It provides a model for the effective implementation of industry-financial integration. In the next stage, the operation and maintenance cost management of power grid equipment also needs to pay attention to the following aspects:

6.1 Promote explicit management of operation and maintenance costs

Input and manage the basic information of equipment well, update the ledger information for the newly added or scrapped equipment in technical reform in time, and strengthen the monitoring and management of basic data. Standardize the operation and maintenance task sheet recording system, strictly implement the preparation of work ticket and work task sheet for the operation and maintenance of power transmission and transformation, strengthen the input of operation and maintenance task sheet information system, reduce, or avoid manual bills.

Strengthen the cost collection of single equipment or unit assets, standardize the use of cost items, and clarify the cost collection caliber of each operation.

6.2 Optimize the standard cost system for operation and maintenance

The revision and compilation of power transformation, transmission, communication, and regulation systems shall be carried out, the standard cost system of power distribution and marketing shall be established, the standard operation database of operation and maintenance shall be established and improved, and the types of operations shall be improved. According to the maintenance business rules and process flow, update the quota standard of material, labor, and mechanical shift consumption for a single operation, determine the unit price standard for each operation in consideration of the material price and employee salary, and calculate the cost standard for a single operation. Combined with the operation frequency, the consumption of installation materials and use frequency of each type of equipment are summarized layer by layer to form the annual maintenance and maintenance cost standard of each specialty. Through the analysis and comparison with the original cost standard, budget arrangement and actual cost, optimize the balance and form the cost standard of each specialty.

6.3 Strengthen precise investment in operation and maintenance costs

Based on the standard cost of operation and maintenance, combined with individual factors such as equipment status, age structure, terrain conditions, regional salary level, etc., building a differentiated input model for maintenance operation and maintenance costs, researching the adjustment coefficients of different influencing factors, and calculating the differentiated operation and maintenance costs of different types of equipment, implement differentiated and accurate investment in operation and maintenance costs, and guiding the rolling correction of the standard costs of operation and maintenance.

6.4 Optimize asset life cycle management

In the selection and procurement stage, the power grid company should inspect the quality of source equipment, improve equipment selection, and purchase technical standards, improve the quality of networked equipment, increase initial investment, pay attention to the full life cycle cost of supplier equipment during operation, form effective assets and reduce subsequent maintenance cost. In the operation and maintenance stage, the power grid company should research and improve asset operation and maintenance strategies, improve technical standards, strictly implement maintenance operation and maintenance strategies, carry out standardized maintenance and other tasks, improve operation and maintenance efficiency, strengthen management and control of the entire process of on-site operations, ensure operation quality and safety, and promote maintenance operations performance improvement of maintenance operations.

References

1. Notice of the National Development and Reform Commission. Provincial Grid Transmission and Distribution Price Pricing Measures (Fagai Price Regulation [2020] No. 101) [EB/OL] (2020)
2. H. Wu, Y. Wei, etc., Research on the practice of transmission and distribution standard cost based on the cost of single asset overhaul operation and maintenance[J]. Guangxi Electric Industry, **5**, 109-113 (2003)
3. Y. He, X. Lu, etc., Research on the Life Cycle Cost of Assets Based on "Each Equipment"[J]. Hebei Electric Power Technology, **1**, 56-59 (2020)
4. S. Ma Shujing, Research on optimization of power grid equipment operation and maintenance strategy based on life cycle management[J]. Qinghai Electric Power, **4**, 66-69 (2015)
5. X. Wang. Research on cost control model of equipment operation and maintenance stage for power grid enterprises[D]. Tianjin: Tianjin University, 41-53
6. X. Liu. Research on the cost of power equipment condition maintenance based on life cycle management[J]. Jiangsu Electric Engineering, **5**, 74-76 (2016)
7. L. Wu. Research on Cost Management of TS Power Supply Company Based on Activity-Based Costing[D]. Hangzhou: Zhejiang Sci-Tech University (2018)
8. J. Guo, Research on the Budget Management Strategy of Power Grid Enterprises' Maintenance Operation and Maintenance Based on Activity Cost[J]. Times Economics and Trade, **1**, 83-85 (2020)
9. W. Sun. Research on Asset Life Cycle Cost Management[D]. Beijing: North China Electric Power University (2018)