Feasibility Study on the Calculation of Geotechnical Investigation Cost of Transmission Line Engineering

--Taking a 500 kV Transmission Line Project an Example

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Abstract. The "National Grid Corporation of China Transmission and Transformation Engineering Survey and Design Fee Estimation Standard (2014 Edition)" has been in use for than 10 years since its release. This paper aims to clarify the charging principle of survey fees for transmission line projects by detailed analysis of the calculation rules in the document and introduce usage of this document with an example of a 500kV transmission line project in a certain region.

Keywords: Transmission line; survey fee calculation research; project example.

1. Introduction

On September 1, 2014, the Power Construction Budget Station of State Grid Corporation of China issued the "Notice on Printing and Distributing Budget Estimation Billing Standards for Survey and Design of Power Transmission and Transformation Projects of State Grid Corporation of China (2014 Edition)" (State Grid Electricityination [2014] No. 19, hereinafter referred to as "Document No. 19"). Document No. 19 stip:

(1) The transmission line engineering applying the Hailawava aerial photo technology, cancel the coefficient of measuring house distribution and optimizing path of the fully digitalogrammetry system.

(2) If the path length of the line is less than 5 km, the charge shall be calculated as 5 km; if the length is than 5 km, the charge shall be calculated as the actual length; if the survey radius of multiple π lines or modified lines in the same power transmission and transformation project is 5 km, the charge shall be calculated as the cumulative length of the lines.

(3) Except for the above provisions, the survey cost shall be calculated according to method of Document No. 10.

That is, except for (1) and (2) as special provisions, other charging methods shall be implemented in accordance with national, and the charging provisions for the survey cost of the overhead line engineering in Document No. 10 shall be analyzed below.

2. Survey cost calculation standard for power transmission line engineering

Consistent with industry standard regulations, the engineering survey fees in Document No. 10 also adopt the method of charging by physical quantity, i.e. Engineering Survey Fees = Basic Price of Engineering Survey Fees × Physical Work Quantity × Additional Adjustment Factor.

The basic price table for engineering survey fees for overhead line projects shown in Table 1.

Table 1. Pricing Basis for Overhead Transmission Line Engineering Survey

Serial number	Voltage level (kV)	Stage	unit	Charging base price (yuan)				
				I	II	III	IV	V
1	≥500	Preliminary Design	km	1303	1902	2605	3777	4950
	330			1107	1615	2213	3209	4205
	220			651	950	1302	1888	2474
	110			495	723	990	1436	1881
2	Corresponding voltage level	Construction drawing design		Additional adjustment factor 4.0				

The table of additional adjustment coefficient for overhead transmission line engineering survey charge is shown in Table 2.

Table 2. Adjustment coefficient table for overhead transmission line engineering survey fees

Serial number	Work content	Additional adjustment coefficient	Note
1	35kV and below transmission project	0.43	The basic price for charging is the charging standard for 110kV facilities in Table 2-1.
2	Optimization path of fully digital photogrammetry system	1.00	The basic price for charging is the charging standard for 110kV facilities in Table 2-1.
3	110kV, 220kV construction stage is divided into two times for survey.	1.20	
4	Heavy ice area		
5	Stability evaluation		
6	Increase tower base shape measurement	1.15	
7	Double-circuit tower		
8	Measure the distribution of houses	1.10	
9	Measure soil resistivity and earth conductivity	1.40	
10	Areas of concealment account for >60% of the line length	1.30	
11	The length of the line survey in the preliminary design stage exceeds 1.5 times the length of the scheme design, and the cost is charged according to the corresponding standard of the power transmission project.		
12	The line length is less than 5 km, and the charge is calculated as 5 km.		

The complexity of overhead line engineering survey is shown in Table 3.

Table 3. Complexity Score Table for Overhead Transmission Line Engineering Survey

complexity	I		II		III		IV		V	
Factor classification	Factor	Score	Factor	Score	Factor	Score	Factor	Score	Factor	Score
Terrain	flat or slightly sloping terrain	1	The terrain is slightly undulating with a height difference of ≤20m in the gentle hilly area.	3	The terrain has a large undulation with a height difference of ≤80m in the mountainous area.	6	The terrain has large undulations with a height difference of ≤150m in the mountainous area.	10	The terrain fluctuates greatly, with a height difference of >150m in mountainous areas.	14
Unobstructed passage	Open country with good visibility; a plain or prairie with easy passage	10	High grass, high crops, woods, bamboo groves; areas of concealment ≤20%; some weeds and low crops or terraced areas of lower height	16	High grass, high crops, woods, bamboo groves; concealed areas with an area of ≤40%; easily accessible swampy water network, terraced areas large differences in elevation.	22	High grass, high crops, woods, bamboo groves; areas of concealment ≤ 50%; deserts, more difficult to traverse waterways, sw, deeper gullies, rocky peaks and outcrops and areas of difficult access	28	High grass, high crops, woods, bamboo groves; concealed areas accounting for >50%; mountainous areas with steep ridges and valleys, severe terrain inc, difficult to climb; swamps difficult to travel through; dense thickets of thorny bushes	36
landform	houses, mines, geological survey points (lines), ditches, roads, water systems, irrigation networks and various pipelines, etc., with an area＜ 5%;	1	houses, mines, geological survey points (lines), ditches, roads, water systems, irrigation networks and various pipelines, etc., with an area＜ 10%	2	houses, mines, geological survey points (lines), ditches, roads, water systems, irrigation networks and various pipelines, etc., with an area ＜ 25%	3	houses, mines, geological survey points (lines), ditches, roads, water systems, irrigation networks and various pipelines, etc., with an area ＜ 40%;	4	Buildings, mines, geological survey points (lines), ditches, roads, water systems, irrigation networks and various pipelines, etc. with an area >40%	5
Engineering geology	Simple geological structure and single stratigraphic lithology (mainly Class I rock and soil);	2	Geological structure, stratigraphic lithology is relatively simple, bad geology and special geological phenomena are very few (mainly Class II rock and soil)	5	Geological structure, lithology of stratum is relatively complex, bad geological phenomena are relatively developed, and special geological phenomena are more (mainly Class III and soil).	8	The geological structure is complex, the lithology of the strata changes greatly, the geological phenomena are developed, and there are many special geological phenomena (ly Class IV rocks and soil).	11	The geological structure is very complicated, the lithology of the strata is diverse and complex, and the scale of unfavorable geology and special geological is large and complex (with Class V rock and soil as the main part).	14
Hydro-meteorology	Basic data is complete; the hydrological situation is simple.	1	Basic data is relatively complete and the hydrological situation is relatively simple.	2	Lack of basic data; complex hydrological conditions;	3	Lack of basic data; complex hydrological conditions;	4	Lack of basic data; the hydrological situation is extremely complex.	5

Note: For soil classification and identification, see the national standard "Code for Geotechnical Engineering Investigation".

The complexity of overhead line engineering survey is shown in Table 4.

Table 4. Complexity classification of overhead line engineering survey

Project Category	complex category	I	II	III	IV	V
transmission	value	12	21	34	50	67

Note: If the complexity score is between two brackets, the charging is calculated by interpolation.

Through comparative analysis, it can be seen that the national standard, industry standard and enterprise standard of the survey cost of overhead transmission line engineering are basically the same and the industry standard and enterprise standard are implemented in accordance with the national standard. The industry standard relatively lowers the minimum length charging specification stipulated by the national standard, changing fromless than 10 km is calculated as 10 km" to "less than 5 km is calculated as 5 km"; the enterprise standard relatively adds the stipulation the related additional adjustment coefficient is cancelled when the application of Hailawara aerial photography technology is used, which further improves the charging specification of the survey cost of overhead line engineering.

3. Engineering example

In a certain area of Henan Province, a 500kV line project, the meteorological conditions are wind speed of 27m/ and ice covering of 10mm. The construction is single-circuit with a path length of 6.3km. The project has a flat terrain, and the ge is mainly Class II rock and soil, with limited hydrological data. The engineering survey unit carried out final survey and positioning in stages.

Based on the above information, we can get the engineering survey complexity scoring table as shown in Table 5.

Table 5. Complexity Score Table for Survey of a Certain 500kV Line Project

Factor classification	Factor	Complexity	Score
Terrain	flat or slightly sloping terrain	I	1
Unobstructed passage	High grass, high crops, woods, bamboo groves; areas of concealment ≤20%; some weeds and low crops or terraced areas of lower height.	II	16
Landform	houses, mines, geological survey points (lines), ditches, roads, water systems, irrigation networks and various pipelines, etc., with an area ≤ 5%;	I	1
Geology	Geological structure, stratigraphic lithology is relatively simple, bad geology and special geological phenomena are very few (mainly Class II rock and soil).	II	5
Hydro-meteorology	Short basic data period; complex hydrological conditions.	III	3
Complexity level score:	26		
Complex category:	II+ 0.38		

According to the score of complex category:

Survey charge base price in the preliminary design stage=(2605-1902)/(34-21)*(26-21)+1902=2172 yuan/km;

The length of the line is greater than 5 km and less than 10 km, calculated as 10 km;

The additional adjustment coefficient in the preliminary design stage is shown in Table 6:

Table 6. Adjustment coefficient table for a certain 500kV line project in the preliminary design stage

Serial number	Category	Content	Adjustment coefficient
1	Optimization of path coefficient of fully digital photogrammetry system	Not adopt	0.00
2	Heavy ice area survey coefficient	Non-heavy ice (thickness < 20mm)	0.00
3	Stability evaluation coefficient	Stability evaluation needed	0.20
4	Double-circuit tower coefficient	Not the same pagoda double return	0.00
5	Hidden area coefficient	Hidden area ≤ 60%	0.00
6	Temperature adjustment coefficient	Survey operation environment temperature ≥35 degrees or ≤-10 degrees	0.20
Total adjustment coefficient:	0+(0+0.2+0+0+0.2+1)=	1.40	

Base price of engineering survey charge in the preliminary design stage=2172 yuan/km*10km*1.4/10000=3.04 ten thousand yuan.

Charging base price of construction drawing stage project survey=Preliminary survey charge base price*4=8689.54 yuan/km.

The additional adjustment coefficient in the construction drawing stage is shown in Table 7:

Table 7. Additional Adjustment Coefficient Table for Construction Drawing Stage of a Certain 500kV Line Project

Serial number	Category	Content	Adjustment coefficient
1	Final survey, positioning and phased survey coefficient	Survey twice	0.20
2	Heavy ice area survey coefficient	Non-heavy ice (thickness < 20mm)	0.00
3	Stability evaluation coefficient	Stability evaluation needed	0.20
4	Tower base shape measurement coefficient	Tower base shape measurement is required	0.15
5	Double-circuit tower coefficient	Not the same pagoda double return	0.00
6	Measure the distribution coefficient of the house	Measure the distribution of houses	0.10
7	Hidden area coefficient	Hidden area ≤ 60%	0.00
8	Temperature adjustment coefficient	Survey operation environment temperature ≥35 degrees or ≤-10 degrees	0.20
Total adjustment coefficient:	0.2+0+0.2+0.15+0+0.1+0+0.2+1=	1.85	

Charging base price of construction drawing stage project survey=8689.54 yuan/km*10km*1.85/10000=16.08 ten thousand yuan.

Because this project needs to measure soil resistivity and earth conductivity, Therefore, calculate the survey charge base price of soil resistivity=8689.54*0.4*10*(1+0.2)=41709.78=4.17ten thousand yuan

The total benchmark price for construction drawing stage engineering survey charges=16.08+4.17=20.25 ten thousand yuan

The voltage level of this project is 500kV, ≥300kV, and the rate of survey operation preparation fee is 0.17.

Preparation cost of this project survey works = (base price of survey charge for preliminary design base price of survey charge for construction drawing)*0.17=3.96 ten thousand yuan;

Compensation for young crops=1000 yuan*10km=1 ten thousand yuan;

Total charge for this project survey=Charging base price+Preparation cost of homework+Other compensation fees=28.25 ten thousand yuan.

4. Conclusion

This paper analyzes the calculation rules in the document "National Grid Corporation of China Budget Estimate Calculation Standard for Survey and Design of Power Transmission and Trans Project (2014 Edition)" in detail to elucidate the pricing principle of the survey cost for power transmission line projects. Taking a 500kV power line project in a certain region as an example, the application method of this document is introduced, aiming to provide a reference for the research on the survey cost of power transmission lines.

References

[1] Shi Weite, Ji Kaileen, Xin Cheng, Wang Ningning, Zhai Huijing. Research on optimization of the general cost of substation projects [J]. China Electric Power Enterprise Management, 2023, (03): 50-51

[2] Li Xi. Research on Cost Control of EPC Project of 110kV YQ Transmission and Transformation Project of S Electric Power [D]. Shandong University, 2022.

[3] Xu Yang, Li Xuyang, Niu Xin, Li Yongjie. Calculation method of integrated bidding limit price for feasibility and design of power grid project [J]. China Electric Power Enterprise Management, 2021, (27): 78-79

[4] Zhu Danju. Design effectiveness evaluation research of a certain 220kV transmission project [D]. Anhui University of Finance and Economics,2021.

[5] Liu Fang. Estimation and Economic Analysis of 110kV Transmission and Transformation Project Investment [J]. China High-tech Enterprises 2016, (21): 170-171.