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# Technical Code for Exploration and Surveying of Large Crossing Overhead Transmission Line

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# Foreword

This code is a revision of the *Technical Regulation of Exploration and Surveying for Large Crossing Overhead Transmission Line* (DL/T 5049—1996) in accordance with the requirements of the *Notice on Issuance of Plan for Supplementing Electric Power Industry Standard in* 2003 *issued by the General Office of National Development and Reform Commission* (FGBGY〔2003〕873).

This code substantially maintains the main framework and contents of DL/T 5049—1996, only making some minor supplements, deletions and adjustments.

As compared with DL/T 5049—1996, the major revisions made herein are as follows:

——The applicable scope is extended to 750 kV transmission lines;

——The contents on GPS surveying, CAD application principles, aerial photographing and surveying, surveying for modification of large crossing transmission lines as well as submission of GIS fundamental data are added in the engineering survey part;

——The contents on seismic safety evaluation, risk assessment of geological disasters, engineering geological surveying and mapping as well as soil resistivity measurement are added in the geotechnical engineering survey part;

——The contents on flood control evaluation for construction projects, analysis and calculation of local scouring, analysis and calculation of ocean current, calculation of wave propagation deformation as well as hydrological data to be submitted at each

design stage for are added in the hydrological survey part.

This code supersedes DL/T 5049—1996 upon implementation.

Appendices A, D, E, F, H, I, J, K, L, M, O and P to this code are normative.

Appendices B, C, G, and N to this code are informative.

This code is proposed by China Electricity Council.

This code is solely managed and interpreted by Technical Committee on Electric Power Planning and Engineering of Standardization Administration of Power Industry.

Chief Drafting Organization: Central Southern China Electric Power Design Institute.

Participating Drafting Organization: Southwest Electric Power Design Institute, East China Electric Power Design Institute, Jiangsu Electric Power Design Institute, and Hunan Electric Power Design Institute.

Chief Drafting Staff: Zeng Qufeng, Wang Shengzu, Rao Zhenxiang, Hu Jiangyun, Cheng Zhengfeng, Liu Deping, Wu Gang, Yao Qilin, Yao Peng, Dai Hongjun, Shi Keqin, Pan Xiaochun, Bie Chuanyan, Peng Tusheng, Liao Aiping, Deng Jiana, Li Zewen, Zhu Jian, Peng Zirong, and Peng Yuhuan.

The code DL/T 5049—1996 was initially issued on January 22, 1996.

This code is translated by SUNTHER Consulting Co., Ltd under the authority of China Electric Power Planning & Engineering Association.

# 1 Scope

This code specifies the basic technical requirements for the engineering survey, geotechnical engineering survey, and hydrological survey of large crossing overhead transmission lines.

This code is applicable to the exploration and surveying of 220 kV-750 kV large crossing overhead transmission lines. It can be taken as a reference for exploration and surveying of large crossing overhead transmission lines at other voltage levels.

In the case of strain sections of lines crossing wide navigable rivers, lakes or straits with large spans (generally above 1000 m) or high towers (generally higher than 100 m) for which special consideration shall be taken in conductor selection or tower design and faults of them may severely influence navigation or are extremely difficult to repair. Under these circumstances, the lines shall be surveyed as large crossing projects.

# 2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this code. For dated references, subsequent amendments (excluding the corrigendum) to, or revision of, any of these publications do not apply. However, parties to agreements based on this code are encouraged to investigate the possibility of applying the latest editions of the normative documents indicated below. For undated references, the latest edition of the normative documents apply.

GB 7930 *Specifications for Aerophotogrammetric Office Operation* 1:500, 1:1000, 1:2000 *Topographic Maps*

GB 18306 *Seismic Ground Motion Parameter Zonation Map of China*

GB 50007 *Code for Design of Building Foundation*

GB 50021 *Code for Investigation of Geotechnical Engineering*

GB 50025 *Code for Building Construction in Collapsible Loess Regions*

GB 50201 *Standard for Flood Control*

GB 50286 *Code for Design of Levee Project*

GBJ 50139 *Navigation Standard of Inland Waterway*

DL/T 5001 *Technical Code for Engineering Survey of Fossil Fuel Power Plant*

DL/T 5084 *Technical Code of Hydrology for Electrical Power Projects*

DL/T 5122 *Technical Code of Exploration and Surveying for* 500 kV *Overhead Transmission Line*

DL/T 5138 *Technical Specifications for Aerial Photographing and Surveying of Overhead Transmission Line*

DL/T 5159 *Technical Code for Geophysical Exploration Electric Power Engineering*

JTJ 213 *Code of Hydrology for Sea Harbour*

# 3 General Provisions

3.0.1 This code is established to unify the technical standards for exploration and surveying of large crossing overhead transmission lines, ensure that the lines are technically advanced and cost effective and the strain sections of the lines can operate safely and normally.

3.0.2 The exploration and surveying of large crossing overhead transmission lines involve engineering survey, geotechnical engineering survey and hydrological survey, aiming at providing accurate and reliable design basis and basic data for the design, construction, and operation of large crossing lines.

3.0.3 The exploration and surveying of large crossing overhead transmission lines shall be divided into three stages consisting of feasibility study, preliminary design and construction drawing design in order to accommodate the requirements of different design stages. If the scheme for large crossing lines is definite and the conditions are simple, these stages can be combined, provided that the design requirements of all stages are satisfied. If there are special requirements for the projects, corresponding exploration and surveying stages can be included.

3.0.4 In the exploration and surveying of large crossing overhead transmission lines, the new technologies and equipment shall be actively promoted.

3.0.5 In addition to this code, the exploration and surveying of large crossing overhead transmission lines shall also comply with the current related national codes and industrial standards.

# 4 Engineering Survey

## 4.1 Feasibility Study Stage

4.1.1 After receipt of an assignment, the surveyors shall learn the project outline, proposed routes, and the requirements to cooperate with relevant disciplines.

4.1.2 The surveyors shall fully collect and make use of existing surveying and mapping results of the areas that the lines will cross. Where necessary, the surveyors may measure indoors the crossing span, elevation difference, plan and profile maps, and coordinates of tower locations for the proposed routes.

4.1.3 The surveyors shall perform field reconnaissance for different route schemes developed indoors, and check the conformity of the existing data with the field conditions, and where necessary, carry out annotation and additional survey.

4.1.4 According to the design needs, the surveyors shall cooperate with the designer to select routes in field, and actually measure the distance and elevation difference between crossing points and the elevation difference from a crossing stake to water surface. The elevation of a crossing stake in the elevation system selected for the water system that the lines cross can be calculated based on the hydrological data.

4.1.5 The surveyors shall locate the proposed routes in field and roughly survey the plan and profile maps. Where plan and profile maps are surveyed indoors through the use of the existing data, then these maps shall be reviewed or inspected in field.

4.1.6 For complex sections on which relevant agreements are reached or those built with complex buildings and structures, the surveyors should roughly survey the plan maps, or measure coordinates and survey plan maps using the aerial survey method.

## 4.2 Preliminary Design Stage

### 4.2.1 General Requirements

The surveyors shall fully collect and make use of existing data according to the requirements of measurement assignment. The collected data of horizontal and vertical control points shall include their names, levels, and systems they belong to. The number of collected benchmark data sets should not be less than two.

### 4.2.2 Connection Survey of Plans and Elevations

1 Where large crossing lines run through the planned urban areas, densely populated areas, and the regions on which relevant agreements are reached such as military facility-occupied areas, ports, and communications and aviation areas, if a uniform plan coordinate system is required, the surveyors shall perform coordinate connection survey to provide the relevant results. Connection survey may be performed using the GPS survey method, traverse method, and intersection method depending upon the actual needs. For the tolerance of connection survey accuracy, the point location error at the tower location center shall generally be no greater than 0.6 mm as shown on the urban planning map of planned urban areas. If there are special requirements, the tolerance of plane connection survey accuracy shall be determined in accordance with these requirements.

2 The connection survey of elevation of large crossing tower location stakes, flood (tide) inundated areas, flood marks and flood water levels may be performed using the Level 1 trigonometric

leveling or mapping leveling. Where the length of the connection survey is greater than 10 km, the fourth-order leveling shall be performed. If there are special requirements, the survey accuracy of elevation shall comply with these requirements. The technical specifications of elevation connection survey shall conform to the relevant provisions as specified in DL/T 5001.

#### 4.2.3 Route Location Survey

1 When performing route location survey, the surveyors shall cooperate with the designer to select in field the crossing tower location stakes and strain tower location stakes on both banks of the large crossing transmission lines.

2 The straight stakes shall be arranged at places where the surveying of distance, elevation difference, plans and profiles, crossing-over, and locations of the stakes can be easily performed and the stakes can be preserved for a long time. The distances between stakes shall be determined according to the requirements for mapping.

3 The straight stakes, angle stakes, and tower location stakes shall be respectively numbered in sequence. Semi-permanent and permanent stakes shall be buried according to the specific conditions of the project. The sizes and buried depth of stakes shall comply with Appendix A.

4 Generally, direct route location shall be performed for straight line route location survey. If barriers exist on the route and obstruct sight line, indirect route location may be performed.

5 Direct route location shall comply with the following requirements:

1) Avoid too less backsight distance and too long foresight distance and the resulting large difference between them;

2) Observe one set of horizontal angles with a permissible deviation of ±30″, after determining the foresight stake location using the reversing telescope center-parted method;
3) The permissible centering deviation when measuring angles using the direct route location method shall not exceed 3 mm, and the permissible deflection of the bubbles in the horizontal circle shall not exceed one grid;
4) The front and back targets shall be in vertical position and the lower part of targets should be collimated. When the back- and fore-sight length is less than 30 m, the instrument shall be strictly centered and leveled, and the collimated targets shall be straight and slim (such as marking pin and pencil points).

6 When erecting additional straight stakes using foresight and backsight methods, the locations of far sighting straight stakes shall be first erected using the reversing telescope center-parted method, and then additional stakes are erected between them. These additional stakes shall be evenly spaced as practical as possible, and the interval between them should not be too small.

7 When performing route location using the indirect method, the surveyors shall estimate the accuracy based on the actually measured conditions. Wooden stakes shall be erected at all the transitional points. Where no conditions for closing or annexing exist, surveying shall be repeated for checking.

8 The indirect route location may be performed using the rectangular method, isosceles triangle method or spur traverse method. The technical specifications shall conform to provisions as specified in Tables 4.2.3-1 and 4.2.3-2.

**Table 4.2.3-1 Technical specifications of distance measurement for indirect route location**

<table>
<tr><td rowspan="2">Instrument Model</td><td rowspan="2">Permissible Centering Deviation (mm)</td><td rowspan="2">Permissible Deflection Grids of Bubbles in the Horizontal Circle</td><td colspan="2">Setting of Survey Points</td><td colspan="3">Distance Measurement Using Total Stations</td></tr>
<tr><td>Methods</td><td>Tolerance (mm)</td><td>Methods</td><td colspan="2">Relative Error of Permissible Discrepancy of Distance Measurement from Opposite Directions</td></tr>
<tr><td>DJ6</td><td rowspan="2">2</td><td rowspan="2">1</td><td rowspan="2">Set the telescope in normal and then reversed position for twice and take the central position as the survey point</td><td rowspan="2">Permissible deviation between two survey points being 2 mm per 10 m</td><td rowspan="2">Observation from opposite directions</td><td>Rectangular method and isosceles triangle method</td><td>Spur traverse method</td></tr>
<tr><td>DJ2</td><td>1/2000</td><td>1/5000</td></tr>
<tr><td colspan="8">Note 1: When using the spur traverse method, the number of the traverse legs shall not exceed four. The lengths of legs shall be uniform as far as possible and the discrepancy between them must not be excessive. The backsight side length of the starting point should be greater than 100 m. The distance measurement reading and calculated result are both accurate to millimeters.<br>Note 2: When using the rectangular method, the vertical distance to the route shall not be less than 25 m.</td></tr>
</table>

**Table 4.2.3-2 Technical specifications of angle observation for indirect route location**

| Instrument Model | Observation Method | Number of Observation Sets | Discrepancy between Semi-observation Sets (″) | Discrepancy between Observation Sets (″) | Reading (″) | Results Rounded off to (″) |
|---|---|---|---|---|---|---|
| DJ6 | Direction method | 2 | 30 | 12 | 6 | 6 |
| DJ2 | Direction method | 1 | 10 | | 1 | 1 |

### 4.2.4 Span and Elevation Difference Measurement

1 The relative error of the large crossing spans shall not exceed 1/1000. If there are special requirements, they shall be complied with.

2 Large crossing spans may be surveyed using GPS or total stations. When using total stations for surveying, observation shall generally be performed for one observation set respectively in opposite directions. If performing observation in the same direction, the height of the instrument or observation target shall be changed. Two observation sets are required, and the median of the values of the two observation sets shall be taken as the final results.

3 The span may be surveyed using the triangle analysis method. The technical specifications shall conform to the provisions in Table 4.2.4-1.

**Table 4.2.4-1 Technical specifications of distance measurement with triangle analysis**

| Instrument Model | Number of Observation Sets | Permissible Discrepancy between Observation Sets (″) | Permissible Relative Error of Baselines | Permissible Relative RMSE of Calculated Leg | | |
|---|---|---|---|---|---|---|
| | | | | 1:1000 | 1:1500 | 1:2000 |
| | | | | Ratio of the baseline length to the calculated leg length no less than: | | |
| DJ6 | 4 | 30 | 1:2000 | 1:28 | 1:14 | |
| | 2 | | | 1:17 | 1:9 | |
| DJ2 | 2 | 10 | 1:4000 | 1:33 | 1:21 | 1:14 |
| | 1 | | | 1:19 | 1:13 | 1:9 |

Note 1: Baselines shall be surveyed using total stations;
Note 2: When establishing the triangle, the included angle between the baseline and the calculated leg shall be between $70^{o}$ and $110^{o}$;
Note 3: The distance must be measured with two figures. When the measurement accuracy is reached, the median is taken as the result;
Note 4: The number of observation sets is applicable to measuring small angles and may be reduced by a factor of two for measuring big ones;
Note 5: Three angles should be measured, and the smallest one will not be involved in calculating closing error. When only two angles are to be measured, the smallest one must be measured.