*Advances in Intelligent Systems Research, volume 156*
7th International Conference on Management, Education and Information (MEICI 2017)

# Power Lines and Distribution Substation Construction under 35KV

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**Keywords:** Power lines below 35KV; Distribution substation; The construction plan

**Abstract.** For below 35 kv power line construction characteristics and difficulties are analyzed, according to the statistics, below 35 kv power line tripping accidents occurred frequently, therefore, proposes a below 35 kv power line and distribution substation construction scheme. To analyze the key technology of transmission lines construction and optimization, to avoid the lightning strike again, mix and match of tripping occur under the influence, on the key technology of transformer substation construction to fastidious, used to be perfect. In order to verify the proposed below 35 kv power line and the validity of substation construction scheme, simulation test was designed, through the experiment proves that the proposed below 35 kv power line and the validity of substation construction scheme.

## Introduction

In the process of power line design and construction, a variety of mutations are often encountered, for example, terrain factors will affect the design route of construction and the setting of relevant operating parameters, while in the design process of power lines and distribution substation, lightning, the countermeasure of mixed use need to be taken into account. If these issues are prevented and responded improperly, it will not only bring great impact on the construction, but also there will be many security risks [1-2]. In order to make the process of power line and distribution substation construction be safe and reliable, the precautionary measures used in the traditional method have some limitations [3-4]. In view of the above situation, this paper presents a construction scheme of power lines and distribution substation lower than 35KV. The key technology of power line construction designed in this paper is to use ZB-type iron stand cross arm of large forging tail, changing the traditional tower made by steel and aluminum, avoiding the phenomenon of trip under the impact of lightning and mixed use, which redesigns and reconsiders the key technology of substation construction and makes a certain improvement. In order to verify the effectiveness of the power line and substation construction scheme under 35KV, the simulation experiment is designed. The validity of the power line and substation construction scheme under 35KV is proved by the experiment.

## Construction Design Scheme of Power Transmission 35KV

### Key Technology Design of Transmission Line Construction

For the power lines and substation construction scheme under 35KV designed in this paper, the key technology of transmission line construction mainly focusses on two aspects. On the one hand, it is based on construction, on the other hand, it is the selection of equipment. The process of basis construction can be mainly divided into the tower assembling and erection construction and the line construction [5-6]. In order to effectively carry out the infrastructure construction and facilitate construction process, effective site selection must be done in terms of the terrain. The tower equipment in the design scheme of this paper adopts high-low leg in all directions with unequal height, which can adapt to more terrain [ 7-8], while reducing the amount of sediment excavation, to ensure that the construction process in the shortest construction period to complete a more solid infrastructure.

The construction process of the tower assembling and erection is a key technology related to the smooth operation of the line. Assuming the obstruction coefficient in the laying process is

$F=\sum_{i=1}^{N} M_i$ and the construction difficulty of the strain tower with the shape of word "干" is $d^2$. The construction progress must consider the time, terrain resistance, construction strength and other factors [9], which can be expressed as a formula:

$$\mathrm{d}=\frac{\ln\left(F-\mathrm{f}\right)\left(\mathrm{d}^2\text{-d-1}\right)}{2\Delta \mathrm{d}\left[\ln F\text{-}\ln F\text{-1}\right]+\left(\ln F\text{-}\ln \mathrm{f}\right)}$$

$$\frac{\ln F\text{-}\ln \mathrm{f}\text{-1}\left(\mathrm{d}^2\text{-d-1}\right)}{2\Delta \mathrm{d}\left[\ln\left(F-\ln \mathrm{f}\text{-1}\right)\right]}+\frac{\left(\mathrm{d}^2\text{-d-1}\right)}{\left[\ln F\text{-}\ln \mathrm{f}\text{+1}\right]} \tag{1}$$

In the formula: $\mathrm{f}$ is the construction time; $\Delta \mathrm{d}$ is the terrain resistance difference in the construction process; $\mathrm{d}$ is the factor of construction operating degree. Through the above formula, the construction process of tower assembling and erection in this design adopts combination approach, presenting the design rationality through the data [10]. The selection in terms of equipment, to a certain extent, needs to continue running the calculation, because power transmission system under 35KV is designed in this paper, so the formula of equipment operating parameters is as follows:

$$Match(object_{pre},\ object_c)=\frac{\sum_i (H_{pre}(i)-\overline{H_{pre}})(H_c(i)-\overline{H_c})}{\sqrt{\sum_i (H_{pre}(i)-\overline{H_{pre}})^2 \sum_i (H_c(i)-\overline{H_c})^2}} \tag{2}$$

In the formula: $object_c$ is the construction equipment of LGJK a 3X589 model. For the different ways of construction, the used parameters can be adjusted up and down, but the adjustment range is between [0.75-1.75]; $object_{pre}$ is the operating index in the operating process; $H_{pre}$ is the number of skew factors in construction process; $H_c$ is the adaption parameter of equipment, which can ensure the rigorous match of construction through the parameter setting [10]; $\overline{H_c}$ is the construction equipment limit. The construction process in this paper is set for the power line under 35KV, so a certain limit adjustment can be carried out. The construction process for the transmission line under 35kv is shown in Figure 1.

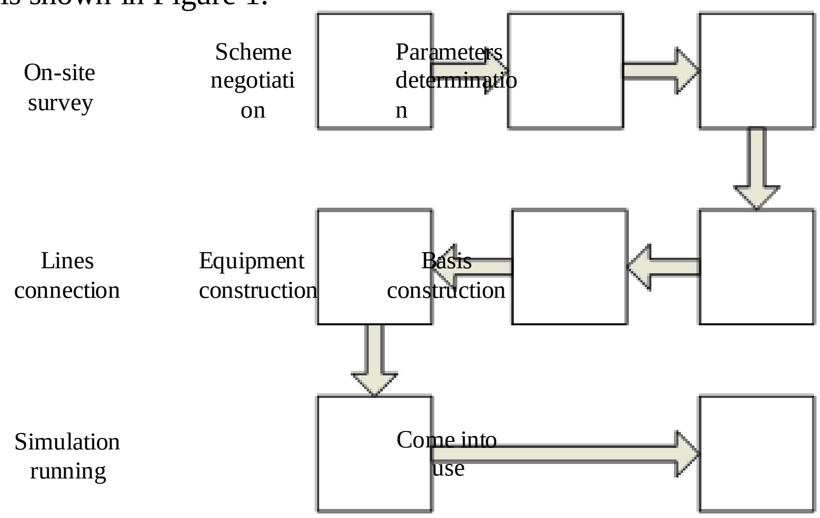


**Fig.1 Construction process of transmission line**

## Key Technical Design of Distribution Substation Construction

In this paper, the key technology of substation construction is mainly for two aspects, one is for lightning protection; the second is the optimization for mixed match. For lightning protection, the traditional method adopts the mode by conducting the lightning, but it cannot avoid the impact of lightning on power distribution. Even through the lightning attack is avoided by lightning rod, it will still cause ionization trip, greatly affecting the use of substation. In view of this situation, this paper uses the form of discharge in transmission. Set the impact of ionization as $H[\mathrm{a}]$, then the formula can be expressed as:

$$
\begin{aligned}
H[\mathrm{a}] &= \frac{\partial^2 \Omega}{\partial v^2} \\
&= -\sum_{i=1}^{n} \mathrm{e}_{\mathrm{k}} \mathrm{w}_{\mathrm{i}} \xi_{\mathrm{ij}} \partial \ell_{\mathrm{i}}^{-1} \left\{ 1.75 \sin\left[1.75 \xi_{\mathrm{i}}^{-1/2}\right] + \xi_{\mathrm{i}}^{-1/2} \cos\left[1.75 \xi\right] \right\} \mathrm{e}^{\xi 2\mathrm{i}/2} \\
H[\mathrm{a}] &= \frac{\partial^2 C}{\partial \mathrm{b}^2} \\
&= -\sum_{i=1}^{n} \mathrm{e}_{\mathrm{k}} \mathrm{w}_{\mathrm{i}} \xi_{\mathrm{ij}} \partial \ell_{\mathrm{i}}^{-1} \left\{ 1.75 \sin\left[1.75 \xi_{\mathrm{i}}^{-1/2}\right] + \xi_{\mathrm{i}}^{-1/2} \cos\left[1.75 \xi\right] \right\} \mathrm{e}^{\xi 2\mathrm{i}/2} \\
H[\mathrm{w}] &= \frac{\partial^2 B}{\partial u \partial v} = \sum_{i=1}^{n} \mathrm{e}_{\mathrm{k}} \cos\left[1.75 \xi_{\mathrm{i}}^{-1/2}\right] \mathrm{e}^{\xi 2\mathrm{i}/2}
\end{aligned}
\tag{4}
$$

In the formula, $\frac{\partial^2 \Omega}{\partial v^2}$ indicates the original ratio of ionization of substation and radiation ionization, and $\xi_{\mathrm{ij}}$ indicates the parameter ionization that the lightning power can produce. $\mathrm{e}_{\mathrm{k}}$ indicates the maximum ionization coefficient that substation can withstand. The latent parameter of distribution substation withstanding ionization obtained by the above formula is $\mathrm{w}_{\mathrm{i}}$. If the ionization coefficient in the discharge process exceeds $\frac{\partial^2 B}{\partial u \partial v}$, then the coefficient of resistance to ionization is $M_i$. The actual ionization value can be calculated through the above formula. Select appropriate anti-ionization equipment in terms of the above values, such as SHI-678HY-type discharge card box. Assume the actual mixing ratio in the remote transmission process is $e^{-TdL[1-pl]}$, then the actual dispersion of distribution substation is:

$$
\begin{aligned}
E &= 1 - \frac{F(q)}{M} \\
&= \frac{\sum_{i=1}^{N} M_i - \sum_{i=1}^{N} M \bullet e^{-TdL[1-pl]}}{M} \\
&= \frac{\sum_{i=1}^{N} M \bullet 1 - e^{-TdL[1-pl]}}{M}
\end{aligned}
\tag{5}
$$

In the formula, E is the parameter of mixing resistance ability of distribution substation; $M_i$ indicates the reference value of the substation in the process of running, $F(q)$ indicates the total discrete ability.

For the different power transmission system, its use conditions have a certain limit; assume that $\mathrm{v}_{\mathrm{j}}^{\mathrm{r}+1}$ is the limit condition of the power transmission system under 35KV; $V_{\mathrm{j}}$ indicates the condition without interference; $\min/V_{\mathrm{j}}$ means there is a certain operational interference; $\sum_{i=1}^{n} \mathrm{w}_{\mathrm{k}} \bullet \mathrm{v}^{\mathrm{k}} + \mathrm{v}_{\mathrm{j}}^{\mathrm{k}}$ indicates the condition of operation interruption. The conditional formula can be expressed as:

$$v_j^{r+1}=\begin{cases} V_j & t_j\text{为非零集} \\ \min/V_j/\min\sum_{i=1}^{n} w_i^2 & t_j\text{为零} \\ v_k^{r+1}+\sum_{i=1}^{n} w_k \bullet v^k + v_j^k & p_j \in^{cm} t_j \\ & m_i(t)=0 \end{cases} \tag{6}$$

Nonzero set
Zero

**Implementation of Simulation Model**

In order to test the accuracy of the power line and substation construction scheme designed in this paper, a simulation test is designed to verify the 35kv ionization line transmission under the remote transmission environment, using conventional electric power equipment with the transmission scheme in this paper for power transmission. Of the program for transmission. In the process of transmission, simulate the condition of lightning.

**Parameter Setting**

To ensure the designed power line under 35KV and distribution substation construction scheme can transmit power effectively, set the following parameters, as shown in table 1.

**Table 1 Parameters setting**

| Test the voltage of lightning attack/KV | Transmission current /A | Transmission voltage /kv | Conditional arguments $v_j^{r+1}$ /mm |
|---|---|---|---|
| **1000** | 300 | 10 | $10^{-4}$ |
| **2000** | 320 | 15 | $10^{-4}$ |
| **5000** | 350 | 20 | $10^{-4}$ |
| **6000** | 380 | 25 | $10^{-4}$ |
| **8000** | 400 | 28 | $10^{-4}$ |
| **9000** | 450 | 30 | $10^{-4}$ |
| **10000** | 700 | 35 | $10^{-4}$ |

**Robustness of Power Transmission**

Power transmission robustness is the index to determine the stability and operating capacity of electric system:

$$B(s)=\int_{\infty}^{-\infty}\exp(-st)\,dB(t)=\int_{-\infty}^{\infty}\exp(-st)\,\delta(t-\tau)dt=\exp(-s\tau) \tag{7}$$

According to the set arguments set in the simulation above and environmental setting, carry out the experiment, and the results are shown below.

**Results Analysis**

**Table 2 Experiment results**

| Method | Robustness in running/ U | SNR /p | Correction parameters |
|---|---|---|---|
| **Scheme in this paper** | **87.58** | **28.96** | **0.35** |
| **Traditional scheme** | **60.02** | **40.07** | **2.00** |

From the analysis results in Table 2, the operational robustness of the designed scheme of power line and substation construction under 35KV is 87.58, which is 27.56U more than the traditional scheme, indicating the construction scheme design of power line and substation under 35KV can run more stably, and SNR is relatively low that the parameters impacting the running capacity are relatively small.

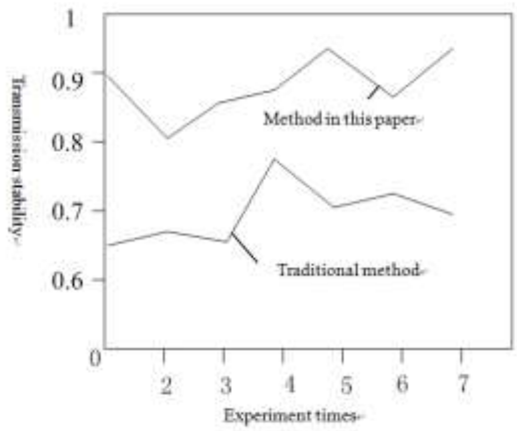


**Fig. 2. Results of the method in this paper**

From Figure 2, the construction scheme design of power line and substation under 35KV following can still maintain high stable transmission in the case of lightning, although there is a certain fluctuation in the operation.

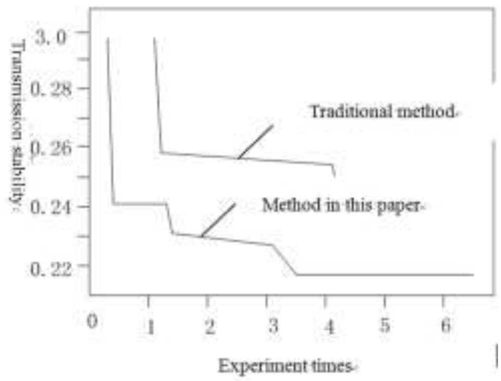


**Fig.3 Test results comparison**

From figure 3, the construction scheme of power line and substation under 35KV designed in this paper has less failure rate than the traditional method, which indicates that the method in this design can effectively avoid the confusion.

## Conclusion

This paper designs a construction scheme of power line and substation under 35KV to optimize the key technology of transmission line construction, which avoids the phenomenon of tripping caused by the impact of lightning, mixed match. The key technology of substation construction is restudied to ensure the operation reliability. Hope that the study of this paper can provide a certain theoretical basis for remote transmission construction.

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