EHV TRANSMISSION LINE ICING ANALYSIS AND COUNTERMEASURES RESEARCH

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Abstract: Ice accretion on transmission line usually causes conductor galloping and flashover, and then a large area power outage occurs. For the dangers of transmission line icing, from the generation of the conductor icing to the icing hazard, the detailed reason have been analyzed. The methods of installing phase-phase spacer and anti-swing device have been used to reduce the happen of breakdown.

Three-dimensional laser scanning and imaging technology can be used to build transmission line three-dimensional model. In this model, transmission line corridors and equipment's 3D information can be appeared. Through set the parameters of atmospheric temperature, ice thickness, wind speed, etc. the changes in line sag can be simulated and the clearance between conductor to others can be measured.

PLS-CADD software based LiDAR has many advantages in transmission line maintenance. LiDAR collects data around transmission lines and deliver it to PLS-CADD. PLS-CADD is capable of calculating the real time conditions of transmission lines. Ice on lines in PLS-CADD can be specified as: 1) a combination of ice thickness and ice density, 2) a nominal load per unit length of wire, or 3) any combination of the previous two. In this paper, PLS-CADD has been used on transmission lines to circuit modelling and intelligent detection.

1. INTRODUCTION

Due to the oversize amplitude, conductors swing with ice can lead to phase-phase flashover, hardware fitting shatter, lines broken, tower fell and other serious accidents [1]. In china, conductors swing has occurred many times in some areas, caused heavy economic losses and effected the safe operation of transmission lines. January 2008, ice storm occurred in South China region resulted to the ice thickness of some transmission lines have been significantly beyond the line machinery carrying capacity, the condition of towers fell was general occur and affected the operation of power grids.

2. RESULTS AND DISCUSSION

Phase-phase spacer effectively reduces failure rate of transmission line. In using, when the wire galloping reach a certain level, phase-phase spacer and link hardware fitting will bring a great distortion power on central of spacer and root of link hardware fitting under the action of the tension or compression. Then the carriage of link hardware fitting will break, phase-phase spacer will lose the capability of control phase-phase distance in wire galloping and the phase-phase flashover will happen. In order to prevent this problem, BEHVC has used the phase-phase spacer of flexible link hardware fitting. In wire galloping, this spacer can produce the greatest rotation angel in different plane, the angel can release the distorting force produced by phase-phase spacer and link hardware fitting. Then this will protect the spacer and hardware fitting when the wire galloping.

The traditional ways of measuring spacer manually need to power cut. The distance is difficult to measure and the efficiency of the manual measurement is low, which causes great difficulty to the spacer installation. The laser scanning 3D imaging system can measure the phase-phase distance exactly in hot line and provide accurate data to produce spacer. The method of measuring the phase-phase distance is shown in Fig.1.

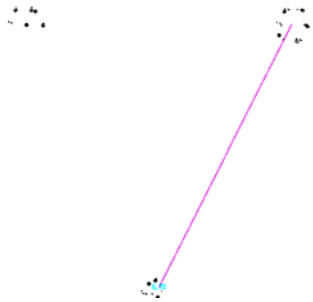

Figure 1: Phase-phase distance measure

3. CONCLUSION

Through the summary for practical experience, install phase-phase spacer will be a good result to prevent the icing galloping. Transmission line 3D model may help operation and maintenance department quickly access the line information and provide reference for spacer production.

4. REFERENCES

[1] Jiang Xing-liang, Ma Jun, Wang Shao-hua, et al. "Transmission lines' ice accident sand analysis of the formative factors". Electric Power ,Beijing, vol38 (11) ,pp. 27-30, 2005

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Keywords- Transmission Line; LiDAE; PLS-CADD

I. INTRODUCTION

Because the reason of topography and micro-meteorological conditions, ice storm accidents occur frequently. In many regions, the ice due to freezing rain leads to increase the load of transmission lines. So the ice result the lines broken, the tower fell, the line flashover and other accidents, tremendous economic losses have been caused [1][2].

Due to the oversize amplitude, conductors swing with ice can lead to phase-phase flashover, hardware fitting shatter, lines broken, tower fell and other serious accidents [3]. In china, conductors swing has occurred many times in some areas, caused heavy economic losses and effected the safe operation of transmission lines. January 2008, ice storm occurred in South China region resulted to the ice thickness of some transmission lines have been significantly beyond the line machinery carrying capacity, the condition of towers fell was general occur and affected the operation of power grids.

II. ICING ESTABLISHMENT

Icing is the generic terms of ice and snow fall on insulator strings and transmission lines in the special meteorological conditions. The formation reason of icing is the freezing rain had overcooled fall to the temperature drop below 0℃ wire and were frozen ice slush, the ice cling the conductor surface and continues to icing. Because the interaction weight of freezing rain and wind, the icing initially come into being on the windward surface of conductors. As the development and accumulation of icing, when the torsion stiffness of conductor cannot resist the flexural torque caused by icing eccentricity and conductor cross-section centroid, the conductor will torsion, so that the icing of conductor surface tend to uniformity. When the torsion stiffness of the conductor is large, such as heavy in section conductor and split-phase conductor, the weight of the uneven icing not enough to lead the wire to reverse or to place wire torsion angle is small, the phenomenon of uneven icing in conductor surface is more prominent.

Icing increase the vertical load of lines, result the increase of wire tension, increase the frontal area of the line, the horizontal wind load will also increase and increasing the occurrence of accidents may break line or fall tower. The vertical icing load will also increase the overhead lines sag, causing accidents owing to the clearance to ground or across object reduced. When the icing detached from the conductor, the lower overhead lines because the sudden release of elasticity will lead to jump, then maybe happen flashover due to the distance reduce to the upper wires.

Conductor galloping is one style of the icing harm for transmission line. When coving with icing and formation of non-circular interface, the conductor will generate the low-frequency and large amplitude vibration inspired by the wind, and easily form tower – line couple system with the tower to amplify the galloping effect. A long time galloping can lead to tower, insulator, conductor and hardware fitting fatigue damage with unbalanced impact and phase-phase or phase-ground flashover. That is serious threat the safe

operation of power grid. So, it is necessary to analyze the conductor galloping causes and explore effective measures to prevent galloping in order to reduce the icing damage of high voltage transmission lines.

III. PREVENTIVE MEASURES

According to the characteristics of transmission line and icing, BEHVC using a variety of ways to prevent and control the icing hazards occurrence.

A. Icing data on-line monitoring system establishment

System Integrated meteorological conditions monitoring (temperature, humidity, wind speed, wind direction, rainfall and air pressure, etc.). Utilizing the predecessor studies to develop the theoretical research include the icing load calculation, icing growth mechanism, towers and hardware fitting strength checkout, conductor galloping and insulator ice-flashover .With the existing powerful mobile communication network, data can be real-time transmission. Expert knowledge database and a variety of theoretical models can give the icing conditions forecasting to effectively prevent ice damage.

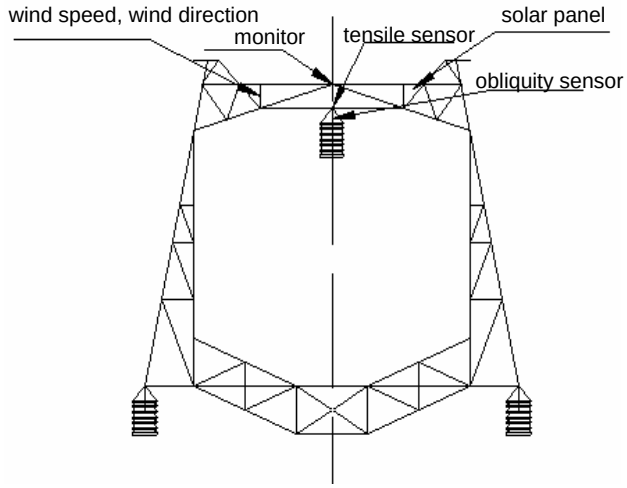

Figure 1. System application

B. Install phase-phase spacer

The goal of installing the phase-phase spacer to split span into several smaller intervals to some tune reduce the span is order to inhibit the occurrence of vibration. Phase-phase spacer can transfer out phase energy of conductor vibration, produce interrelationship in different wires, disorder the wire phases, inhibit conductor vibration and assure phase-phase distance to prevent flashover occurred. The traditional insulating material of spacer is porcelain, a kind of big deadweight material. Because the spacers increase the loads of tower, it is need to consider increasing the strength of the tower. The wires sag will increase, leading to the clearance from the wires to ground do not meet the requirements. Composite phase-phase spacer has the advantages of composite insulators, superior antifouling performance, outstanding mechanical properties, and very light weight. As the light weight and overall rigid structure, the spacer installed between phase to phase neither increase the load of wire and tower, nor happen the phase-phase flashover.

Figure 2. Phase-phase spacer

Phase-phase spacer effectively reduces failure rate of transmission line. In using, when the wire galloping reach a certain level, phase-phase spacer and link hardware fitting will bring a great distortion power on central of spacer and root of link hardware fitting under the action of the tension or compression. Then the carriage of link hardware fitting will break, phase-phase spacer will lose the capability of control phase-phase distance in wire galloping and the phase-phase flashover will happen. In order to prevent this problem, BEHVC has used the phase-phase spacer of flexible link hardware fitting. In wire galloping, this spacer can produce the greatest rotation angel in different plane, the angel can release the distorting force produced by phase-phase spacer and link hardware fitting. Then this will protect the spacer and hardware fitting when the wire galloping.

C. Transmission line 3D model

Through the laser pulse transmitter and receiver and using the high precision GPS and inertial navigation system (IMU), laser scanning 3D imaging system computes the relative spatial position and spatial data. At the same time, the system can create the image of the area scanned through integrating digital camera. This technology makes it easy to get the spatial information actually [4]. The helicopter laser scanning 3D imaging system is made up with 3D laser scanner, GPS, IMU, digital camera, control system and memory.

The compact transmission line in special area is vulnerable because of strong winds, heavy snow and other inclement weather. That can induce the line to wave and lead to phase-phase short circuit. Fixing phase-phase spacer is an important measure to avoid short circuit.

The traditional ways of measuring spacer manually need to power cut. The distance is difficult to measure and the efficiency of the manual measurement is low, which causes great difficulty to the spacer installation. The laser scanning 3D imaging system can measure the phase-phase distance

exactly in hot line and provide accurate data to produce spacer. The method of measuring the phase-phase distance is shown in Fig.4.

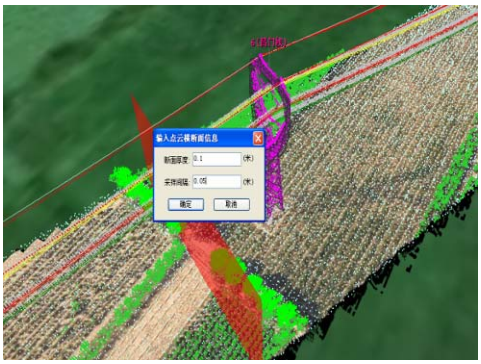

Figure 3. Transmission line 3D analysis system

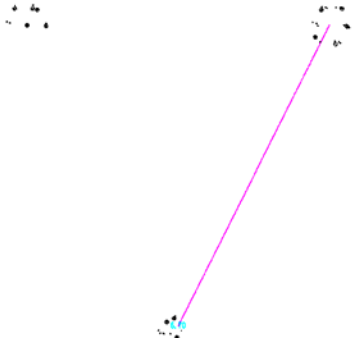

Figure 4. Phase-phase distance measure

The application of laser scanning 3D imaging system in Shangcheng and Gutai 500kV compact transmission lines indicates the system's advantage. The phase-phase distance accuracy is less than 5cm. The result is shown in Tab.1.

TABLE I. INSTALLATION SIZE CONDITION

Name of Line	Number of measure	Installation number	Accuracy rate
Shangcheng 1	448	448	100%
Shangcheng 2	452	452	100%
Gutai 1	321	321	100%
Gutai 2	325	325	100%

The spacers based on the data from the system are fixed successfully just one time. It solves the problem about measurement.

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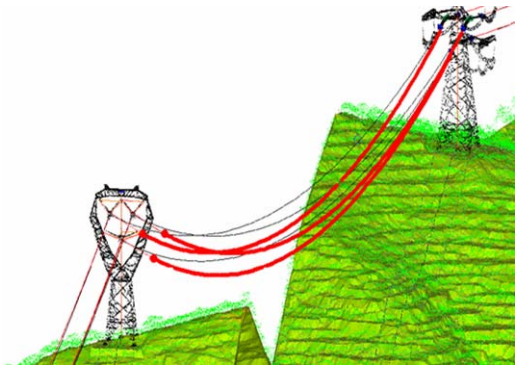

Figure 5. Icing model

IV. SUMMARY

Through the summary for practical experience, install phase-phase spacer will be a good result to prevent the icing galloping. Transmission line 3D model may help operation and maintenance department quickly access the line information and provide reference for spacer production.

REFERENCES

[1] Yuan Ji-he, Jiang Xing-liang, Yi Hui, et al . "The present study on conductor icing of transmission lines". High Voltage Engineering. Beijing, vol 21(4), pp.6-9, 2003

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