http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (17): 4122-4126, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.4122.4126

Planning Program Study for Distribution of Intelligent Monitoring Terminal of Ehv Transmission Line

[1]Huan Chen, [2] Lianwei Bao, [1]Wangchun Luo, [2] Peng Sun and [2] Youyuan Wang
[1]Test and Maintenance Center, CSG EHV Power Transmission Company,
Guangzhou 510633, Guangdong Province, China
[2]State Key Laboratory of Power Transmission Equipment and System Security,
New Technology, Chongqing University, Chongqing 400044, Chongqing, China

Abstract: The operational state of transmission lines affects the power system security directly. Now all kinds of on-line monitoring systems have been installed for the accident-prone transmission lines, by which remote real-time acquisition and analysis process of the information of transmission line status can be achieved and the running situation of the fields can be found out on time for assessing the icing of transmission line and early warning, thus guiding for taking appropriate preventive measures and improving running safe reliability of transmission lines. In this paper, the operational state of transmission lines under the jurisdiction of the ultra-high voltage company is investigated. Failure conditions and defect sections of transmission lines are summarized and the running situation of the existing monitoring system is analyzed. The point-setting principles of UHV transmission lines are made. Based on this, the recommended layout of transmission lines of UHV Company relying on failure frequency is proposed.

Key words: Transmission lines, monitoring device, situation, layout method

INTRODUCTION

Most of the transmission line devices are located in mountains, ravines and wilderness. The operating environment is harsh and complex. Once problems of transmission line devices occur, failures and obstacles cannot be timely discovered, processed and prevented under most of the circumstances (Huang *et al*., 2009). These lead to great difficulty of maintaining transmission line device as well as high costs (Yang *et al*., 2011). Given the complex operating environment for the transmission lines, power operation organizations have carried out many works on online monitoring and warning system of the comprehensive state of transmission line (Chen *et al*., 2009). Among these measures, intelligent monitor terminals are taken as the data sources of the entire system and serve as the "eye" of online monitoring system. Research on the pattern selection and distribution planning of intelligent monitor terminal is of vital importance to the comprehensively understanding of transmission line state, improving monitoring efficiency and reducing the one-off costs of investment. Meanwhile, actual situations presented that most of the existing studies on intelligent online monitoring of transmission lines focused on monitoring devices and system development and integration. Tremendous progresses have been made in the areas of monitoring devices and techniques. However, the application of monitoring devices and systems in transmission line state monitoring has demonstrated certain blindness for the distribution of intelligent monitor terminals, as well as a lack of unified planning, resulting in a mass of resource wastes.

On the basis of operation states of transmission lines of EHV (extra-high voltage) power transmission companies and the application effects of existing monitoring devices, fault types, fault frequency, fault section and other information of each EHV line was analyzed through comprehensive investigation. Next, principles for the distribution of intelligent monitor terminals for transmission lines under the management of EHV power transmission companies were produced. Besides, this research proposed some recommended distribution plans for transmission lines of EHV power transmission companies based on transmission line fault frequency.

CURRENT OPERATION STATE OF TRANSMISSION LINE OF EHV POWER TRANSMISSION COMPANIES

By 2011, the total length of lines at 10 kV and above voltage levels managed by EHV companies reached

Corresponding Author: Huan Chen, Test and Maintenance Center, CSG EHV Power Transmission Company, Guangzhou 510633,Guangdong Province, China

15432.565 km, including 1374.601 km of±800kV lines, 3049.318 km of±500 kV lines, 9873.236 km of 500 kV lines, 199.647 km of 220 kV lines and 935.763 km of 110 kV and below lines. Characteristics of EHV lines include diverse line types, long total length of transmission line, complex and changing geographical and meteorological environments and so on. By re-organizing and collecting various fault data and operation experiences of transmission lines of EHV power transmission companies, the operation states of transmission lines of EHV power transmission companies could be analyzed, providing basic information and data supports for distribution planning of intelligent monitor terminal of transmission lines.

Data collection on fault types of transmission line of EHV power transmission companies: According to the operation information of transmission line of EHV power transmission companies between 2002 and 2011, this research collected data on fault types and fault situations of each transmission line managed by EHV companies. Data showed that between 2002 and 2011, main causes of 351 fault-caused trip-outs include lightning strike, forest fire, pollution flashover, icing, galloping, wind deviation, damages by outer forces, tree discharge, channel abnormity, gale disaster, line disconnection and foreign matter etc.. Lightning strike caused 241 trip-out accidents, accounting for 68.7% of all accidents, followed by forest fire (16.2%). When making monitoring distribution plans, people should highlight the lightning strike and forest fire monitoring, improving the online monitoring quality and reducing trip-out rate of transmission line.

Data collection on fault frequency of transmission line of EHV power transmission companies: It is known that lightning strike is the major reason that causes transmission line trip-out of EHV power transmission companies. With the example of lightning strike fault, this research analyzed lightning strike fault of transmission line of EHV power transmission companies. Lightning strike fault number and per hundred km lightning strike number of each transmission line were selected as statistic indexes. The data on lightning strike fault of each transmission line from 2006 to 2011 showed that lightning strike fault number and per hundred km lightning strike number of Tianguang DC Line, Mabai Transmission Line and Yanhua Line A were top 3 of all lines. Trends shown in Fig. 1 and Fig. 2 demonstratedhat in 2011, lightning strike fault number of each transmission line declined substantially. Among them, lightning strike fault number of Mabai Line remained 2 to 3 each year and this should be especially noted.

Data collection on fault section of transmission line of EHV power transmission companies: Defects of transmission line of EHV power transmission companies primarily include forest fire, lightning strike, icing, flooding, contamination, galloping and damages by outer forces, typhoon and fast growth of trees. Except blooding, other defects can be monitored and took precautions against by online monitoring system. The corresponding monitoring system is forest fire online monitoring system, lightning positioning system, icing online monitoring system, insulator contamination online monitoring system, wind deviation

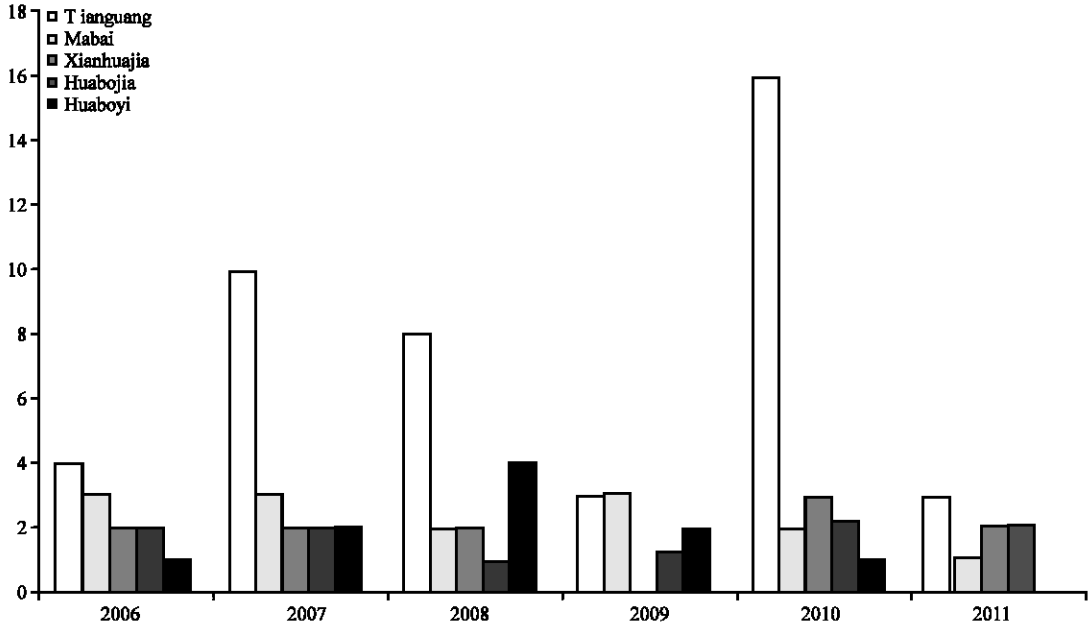

Fig. 1: Number of lighting strokes

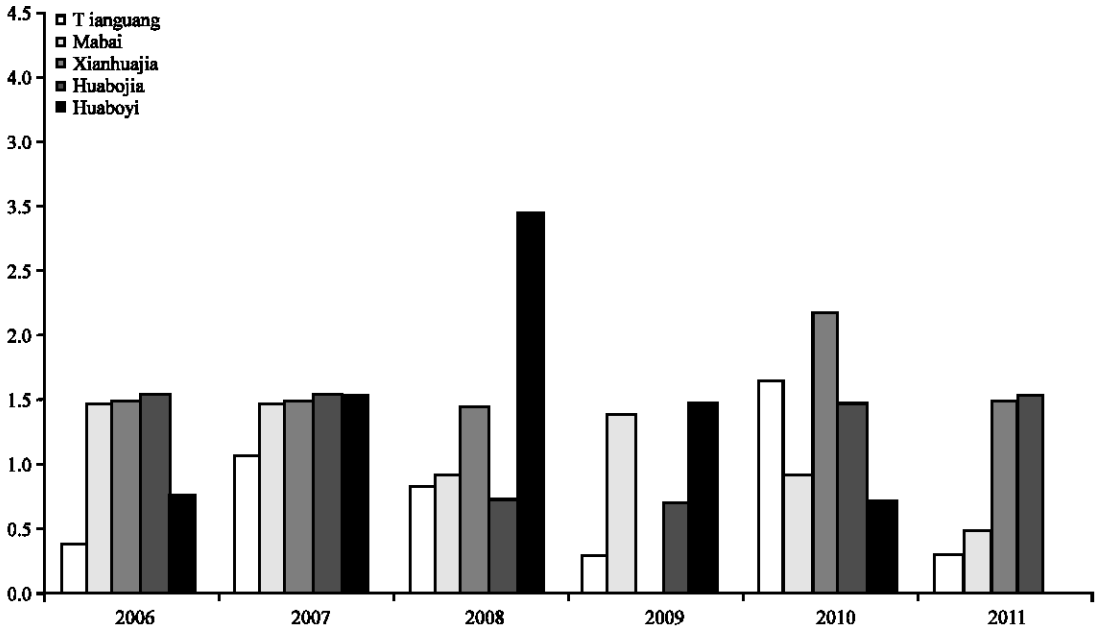

Fig. 2: Number of lighting strokes/100 km

online monitoring ssystem, video online monitoring system and microclimate online monitoring system.

The data showed that lightning induced line accidents and obstacles mainly concentrated on lines managed by Guangzhou, Nanning and Tianshengqiao Bureau Forest fire induced line accidents and obstacles mainly concentrated on lines managed by Liuzhou, Tianshengqiao and Wuzhou Bureau.

ONLINE MONITORING STATE OF TRANSMISSION LINE OF EHV POWER TRANSMISSION COMPANIES

Online monitoring systems by EHV companies include icing online monitoring system and lightning positioning system. Systems under construction include forest fire online monitoring system and dynamic line rating system. Among them, the icing online monitoring system was built and used in 2009, which realized parameter monitoring of line images in possible icing areas within EHV management range, such as tension, meteorological parameters (temperature, moisture, wind speed), leakage current and conductor line temperature etc. The system can support functions like calculating the ice thickness and tension changes, providing tendency curves and data analysis. It also has the alarming function.

According to data on feedback of terminal installation and operation conditions of terminals given by the operation and maintenance organizations, with the example of icing monitoring system, existing problems with icing monitoring system of EHV transmission line primarily include two aspects:

- Relatively low reliability of icing monitor terminal: As most monitor terminals are located in harsh operating environments and the monitoring devices have certain technological defects in R and D, the reliability of devices is generally lower and unable to meet the requirement of consistent and persistent online monitoring. According to the statistical data on terminal operation, it can be seen that the ratio of normal functioning of each part of monitor terminal was lower than 50%. Among 75 sets of icing monitor terminals in operation, only 24 sets are in a normal functioning state (statistics date: 2012-12-10). Therefore, before an extensively distributing of terminals, it is necessary to adopt pilot construction to test the reliability of monitoring devices and ensure the risk controllability of each monitor terminal
- Terminal upgrading and installing: During the terminal upgrading and installing, due to the short power failure time of lines, it is hard to accomplish the extensive installation, debugging and upgrading of terminals during the power failure period. Therefore, it is also a pressing problem to ensure a small terminal number for overall monitoring of potentially risky sections under the condition of safety and economical efficiency

DISTRIBUTION PLANNING

Based on the principles to the distribution of intelligent monitor terminals of transmission lines, the demonstration intelligent monitoring distribution was proposed to be enforced as a pilot project in a relatively

Table 1: Distribution plan of intelligent monitor terminals based on transmission line fault frequency

Planned terminal positions	Fire prevention system	Wind deviation monitoring	Insulator contamination monitoring	Video monitoring	Microclima monitoring
Mabai 15#	√			√	√
Mabai 56#			√		
Mabai 70#	√	√	√		
Mabai 100#				√	√
Mabai 112#				√	
Mabai 323#				√	
Mabai 357#	√	√			√
Mabai 384#			√		
Total number	3 sets	2 sets	3 sets	4 sets	3 sets

concentrated area. This can detect whether the operation reliability of each monitor terminal, resistance to electromagnetic compatibility, wireless communication ability, data transfer rate, monitoring precision, power consumption and other technical indicators can meet the requirements of requirements online monitoring, thereby providing basis for further improvement of the distribution.

Taking into account the particularity of demonstration line distribution planning, in order to prevent the influence of monitor terminal failure in the pilot area on the daily operation and maintenance of key lines, terminal layout should avoid AC and DC lines included in Grade I control devices. Meanwhile, each terminal should be distributed in special areas with multiple hidden dangers and line towers with historical accident-induced faults. Locations of monitor terminals should be relatively concentrated, covering all types of monitoring. The number of terminals should be small but concise. This paper took fault frequency of EHV transmission line as the main basis and integrated fault section of transmission line for monitor terminal distribution planning.

Selection of planned distributed lines: According to the statistical results of fault types and fault frequency of all types of transmission lines managed by EHV power transmission companies, under the premise of avoiding transmission lines included in Grade I control devices, fault types of transmission lines with a relatively high frequency were selected.

The distribution line plan firstly considered the fault types and frequencies happened to each transmission line, took into account fault sections involved and then selected a typical line. In this way, we can ensure the monitor terminal layout is relatively concentrated, covering a variety of monitoring information. The forest fire can be monitored by fire prevention system monitoring while pollution flashover by insulator contamination monitoring system, galloping, wind deviation and gale disaster by wind deviation monitoring system. Video monitoring system can monitor faults like damages by outer forces, tree discharge, channel abnormity, foreign matter and line disconnection. According to typical lines of different fault types, fault sections of transmission lines were considered and Mabai Transmission Line was initially selected as a distribution line.

Five hundred kV Mabai Transmission Line had 3 forest fire trip-out failures during 2006 -2011, accounting for 69.7% of the total trip-out failures. It had 1 wind deviation trip-out, accounting for 25% of all. On the other hand, Mabai Transmission Line covered 41.768 km in the anti-forest fire areas, 8.473 km in the contamination areas and 2.63 km in the forest fire and lightning preventing areas. This could focus on achieving the distribution of line monitor terminals of fire protection systems, wind deviation system, insulator contamination monitoring and microclimate monitoring. In this case, Mabai Transmission Line can reconcile high fault frequency and fault section and it is able to achieve the line selection of early distribution planning.

Selection of planned distribution towers: The operation period of Mabai Transmission Line reached 10 years and the total length of lines managed by Tianshengqiao Bureau is 7850m. The start tower number is #1-#202, sharing several corridors and multiple circuit lines with Tianguang DC Line and Tianping Circuit Line II. It belongs to the key section with hidden danger and shows typicalness. The total length of lines managed by Baise Bureau is 104.262 km and the start tower number is #202-#387. Among them, #230, 248, 250, 285, 327, 347, 355 and 369 stand for forest fire; #353–#358 stand for lightning strike; #323 stands for landslide; #381-#387 stand for contaminant sedimentation; #202-# 380 stand for mountainous areas. Common faults include lightning strike, self-destruction of glass insulator and insulator contamination.

Based on the analysis in the previous section, it was proposed to select Mabai Transmission Line as a transmission line with monitor terminal. With the integration of "data on fault section of transmission line of EHV power transmission companies", towers in the section of typical operation conditions were selected as pilot towers for making the specific terminal layout program (Table 1). These towers were mainly selected for the following reasons:

- Take full account of parallel lines, that is, the section sharing corridors and multiple circuit lines
- Selected towers are mainly located in fault sections like forest fire and contamination etc, showing no corresponding preventive measures
- Take full account of the environment along the line, especially the contamination monitoring of severely polluted areas
- Take full account of factors like air temperature, moisture, wind speed and wind direction as main meteorological factors that influence the fire severity of transmission line. Therefore, for forest fire fault section, microclimate online monitoring equipments will be increased

CONCLUSION

This research analyzed operation states of transmission lines managed by EHV companies and the status of transmission line online monitoring, as well as the current problems with EHV transmission line online monitoring. The research proposed that distribution plans of intelligent monitor terminals of transmission lines should be developed for key lines managed by EHV companies and completed distribution types. This could enable the economical and effective understanding of transmission line operation states and laying the foundation for establishing an intelligent online monitoring system of transmission line and realizing line state estimation.

REFERENCES

Chen, H.B., C. Wang, J.F. Li, C. Wang and G. XU, 2009. Application of on-Line monitoring technologies for UHV AC Transmission Lines. Power Sys. Technol., 10: 55-58.

Huang, X.B. and G.W. Zhang, 2009. Status quo analysis of online monitoring techniques of transmission lines. Guangdong Electric Power, 1: 13-20-34.

Yang, Q.P., D.F. Xu, F. Dong and Z.W. Deng, 2011. Development of advanced transmission line safe operation system in smart grid. J. Shanghai Univ. Electric Power, 5: 471-476.