Research and Application of Transformer-User Identification Technology Based On Fault Diagnosis of Electrical Information Acquisition Equipment

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Abstract. The line loss rate of power supply enterprises is an important economic and technical index, which directly reflects the lean level of marketing professional management of power supply enterprises. At present, the confusion of transformer-user archives in transformer area is still widespread, which is a key issue in line loss management in power supply enterprises. As the downlink communication channel, low-voltage power line carrier can realize cross-station reading, which brings great difficulties to the identification of transformer-user relation. Because the data of calculating the line loss rate of the transformer area depends on the electrical information acquisition system, the running state of the electrical information acquisition equipment is also one of the important factors affecting the line loss rate of the transformer area. This paper will focus on the fault diagnosis technology of electrical information acquisition equipment, and use it to carry out the identification of transformer-user transformers.

1 Introduction

1.1 Significance of Research on Transformer-User Archives Identification

With the continuous development of economy and society and the further deepening of the reform of electric power system, power grid enterprises are facing enormous challenges in transforming the revenue-earning model. With the increasing demand of enterprises for cost reduction and efficiency enhancement, line loss management in Transformer area has gradually attracted the attention of power grid managers at all levels. The factors affecting the line loss rate include abnormal transformer-user archives, power theft by users, data acquisition failure, etc. Abnormal transformer-user archives often cause incorrect statistics of line loss rate in multiple stations, which is also the most difficult type of abnormal operation and maintenance. The identification technology of transformer-user archives in Transformer area has attracted more and more attention of power grid enterprises at all levels. Due to the change of user information, the replacement of meter faults, the alteration of transformer area and the fault of distribution

transformer, it is difficult to straighten out the corresponding relationship of transformer-user transformer at present. In addition, the existing low-voltage power line carrier, micro-power wireless and other communication modes have the ability of cross-station communication and reading in the case of "common zero line" and coupling, which brings difficulties to the abnormal detection of transformer-user archives relationship. At present, the main methods of identification of transformer area transformer-user transformer include transformer area blackout identification, transformer area identification instrument, power frequency zero-crossing sequence identification, and HPLC identification, among which transformer area blackout identification is widely used at present, but this method is only used during the period of transformer area maintenance blackout, otherwise it may cause complaints from power users. In addition, all kinds of transformer-user archives identification methods have certain limitations, so the research of transformer-user archives identification technology in Transformer area has great significance for the development of power enterprises.

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1.2 Brief Introduction of Fault Diagnosis Technology for Electric Information Acquisition Equipment

As the terminal level of smart grid development and construction, electrical information acquisition equipment may have various kinds of faults due to comprehensive reasons such as user information change, meter fault replacement, and station upgrading and transformation. At the same time, the power network topology is becoming more and more complex, the existing acquisition equipment does not support the lean management of marketing in place, the management mode is extensive, the manual response of electrical information acquisition equipment is slow after abnormal problems occur, the ability level of field maintenance personnel is weak, it is difficult for operation and maintenance personnel to diagnose the fault of electrical information acquisition equipment quickly, and its fault analysis occupies a large number of places. Operational and maintenance costs. In order to effectively solve the difficulty of operation and maintenance at the grass-roots level, power enterprises analyze and process the data of electrical information, and summarize a set of corresponding fault diagnosis algorithms for electrical information acquisition equipment. Some power enterprises deploy them in power users' electrical information acquisition system, while others deploy the diagnosis algorithms in self-developed fault diagnosis devices for electrical information acquisition equipment. This paper mainly focuses on the application of fault diagnosis device of electric electrical information acquisition equipment to carry out transformer-user variable identification.

2 Introduction of Fault Diagnosis Device for Electric Information Acquisition Equipment

2.1 Brief Introduction of the Fault Diagnosis Device

As a supplement to the concentrator function, the fault diagnosis device of acquisition equipment obtains meticulous metering and non-metering data of watt-hour meter in the transformer area which is difficult to acquire by the electrical information acquisition system. By

using the analysis algorithm and model, combined with the edge computing technology, it realizes the connection relationship of low-voltage transformer area transformer-user archives, abnormal power consumption, operation error of watt-hour meter, phase identification, precise calibration, transformer area topology, network. Topology and other anomalies are analyzed, and effective management of transformer-user archives in low-voltage stations is realized. We can see the topological structure and abnormal details of the entire transformer area on the field operation terminal, which can provide effective support for the field operators. Combining the field operation terminal and the closed-loop management module of acquisition, operation and maintenance, we can achieve the goal of multi-dimensional, efficient and intelligent management of the station site.

2.2 Installation Mode and Principle of the Fault Diagnosis Device

The fault diagnosis device of acquisition equipment is attached to the concentrator side and connected to the concentrator through RS-485 or RS-232 communication mode. Fault diagnosis device of acquisition equipment can set data information of automatic reading concentrator or electric energy meter. It can also use the analysis model and algorithm constructed, combined with edge computing technology to analyze the abnormal situation of the transformer area, and save the abnormal results and related data. District managers use the field operation terminal to obtain the abnormal results and related data of fault diagnosis device of acquisition equipment by Bluetooth wireless communication. After analysis, they can visualize the operation status and abnormal situation of the transformer area, differentiate and display the abnormal situation, and generate a summary list of abnormal data. The field operation terminal stores the data of fault diagnosis device of acquisition equipment, and supports the field direct processing of abnormal problems and the processing of reporting closed-loop module. When reporting to the closed-loop module, the closed-loop module generates abnormal work orders according to the reported abnormal data and dispatches them for processing.

The installation of the device is shown in the following figure.

Figure 1. Installation principle diagram of fault diagnosis device for electrical information acquisition equipment.

2.3 The Function Introduction of the Fault Diagnosis Device

The device will obtain file information, voltage curve data, current curve data, power, power factor, energy meter event record, calendar clock and other basic data from the concentrator or through the energy meter, so as to achieve the following functions.

2.3.1 The analysis of transformer-user corresponding relation.

The fault diagnosis device of acquisition equipment can effectively identify the ownership relationship between the user table and the region by acquiring the current connected concentrator files and the curve data of

voltage, current and power of each measuring point, and discover the wrong users by using the analysis model of the user relationship.

2.3.2 The analysis of abnormal electricity consumption.

The fault diagnosis device of acquisition equipment reads the frozen data of each watt-hour meter in the connected concentrator, the event records of watt-hour meter and the data of reading watt-hour meter through transmission. It includes open-cover recording of electric energy meter, open-end button box recording of electric energy meter and blackout event recording. Through the analysis of the algorithm, the corresponding abnormal events of power consumption are obtained.

2.3.3 The analysis of operation error.

Firstly, an error analysis model is established based on archive data and energy meter data. There are electric energy indicator of electric energy meter for 3 consecutive times. If the second data is less than the first data, and the last data is larger than the first data, then it is judged that there is a watt-hour meter reversal event. If the total electric energy indication value of the watt-hour meter is not equal to the sum of the electric energy indication value of each rate, it is judged that the electric energy indication value is not abnormal.

2.3.4 The transformer area phase recognizing technology.

The method of phase identification of power line carrier in the transformer area is preferred. For those stations which do not have this function, large data method is used to identify them. Voltage data and current data of 12 points per day of watt-hour meter at least 3 days are selected to extract features from voltage data. Then phase recognition model is generated by correlation analysis based on these features. The complexity of phase recognition model is controlled by regularization or data enhancement to avoid the situation that the model is not suitable for new data.

2.3.5 Clock governance.

Fault diagnosis device of acquisition equipment collects clock information of all watt-hour meters in fixed time period every day, and compares it with concentrator clock. When broadcasting calibration is initiated for watt-hour meters whose clock error exceeds 5 minutes, the clock of watt-hour meters in the station area is calibrated. At the same time, we can use the field operation terminal to show the clock overshoot in the desk area.

3 Application of Acquisition Equipment Fault Diagnosis Technology to Realize Transformer-User Variability Recognition

3.1 The Identification of Transformer-User Archives by Power Outage Data

This recognition method relies on the accuracy of reporting power failure events of concentrators and watt-hour meters. It is a method with poor active recognition ability. It needs to be applied in the maintenance of line in the transformer area, and has some limitations.

3.1.1 The judgment rules of transformer-user archives identification by power outage data.

The power outage in the transformer area can be judged by the terminal outage event and the meter outage event under the terminal. Firstly, the terminal information is found by recording the power outage of the terminal. According to the terminal information, whether there is a meter outage under the terminal is found. If there is a meter outage, it can be judged that there is a station outage in the terminal area. Attention should be paid to ensuring the effectiveness of blackouts when applying this method, that is, there must be a reasonable blackout event corresponding to it.

3.1.2 Make full use of historical data to carry out census of transformer-user archives.

In addition to the identification of transformer-user archives, the technology can also be used to evaluate the quality of transformer-user archives and census transformer-user archives. Large data analysis and data mining technology can be used to comprehensively analyze the historical power outage events of terminals and watt-hour meters, and accurately match the corresponding relationship between the transformers and users.

3.2 The Identification of Transformer-User Archives by Analyzing Abnormal Events and Data

Fault diagnosis device of acquisition equipment can effectively identify the ownership relationship between user table and region by acquiring the data collected by the current connected concentrator and using the analysis model of user-change relationship, and discover the user with incorrect connection relationship between user-change.

3.2.1 Screening the abnormal events of voltage and current to identify transformer-user archives.

Fault diagnosis device of acquisition equipment can analyze the loss of voltage and current events occurring under the transformer area. If multiple loss of voltage and current events occur simultaneously in groups, relevant data can be retained to judge the identification of transformer area transformer-user archives. The identification method is similar to that of using station power outage events to realize the identification of transformer-user archives.

3.2.2 Screening the curve data of voltage and current to identify transformer-user archives.

Firstly, the curve data of voltage, current and power of each measurement point (including AC sampling data, assessment table data and user table data) under the concentrator are obtained. On the premise of ensuring good collection quality, the correlation of each measurement point is evaluated by linear regression

analysis, and the actual relationship of the desktop is judged according to the correlation strength.

4 Concluding Remarks

This paper makes a comprehensive analysis and discussion on the fault diagnosis technology of the power consumption information acquisition equipment, the identification service of the transformer-user relationship and the close relationship between the two. In addition, we also systematically demonstrate the research in the field operation and maintenance business of line loss management in transformer area. Finally, we found that the identification of transformer-user archives based on outage data and the identification of transformer-user archives based on abnormal events are applicable to the management of transformer-user archives. As long as the analysis algorithm of outage data and abnormal events is perfect enough, the accurate relationship between transformer and user can be obtained.

The functions of the fault diagnosis device of the power consumption information collection equipment, such as the phase identification and the topological structure analysis of the transformer area, can really improve the work efficiency of the identification business of the transformer-user archives. The use of the fault diagnosis device of the power consumption information collection equipment can provide assistance to the identification of the transformer-user archives to a certain extent, achieve the purpose of the management of the line loss in the transformer area, so as to achieve the ultimate goal of improving the economic benefits. At present, the technology is not perfect enough, and the recognition accuracy is not high. At this stage, the core task is to improve the operation stability of fault diagnosis equipment of acquisition equipment and the quality of data analysis algorithm of diagnosis model, and to reduce the misjudgment rate and missed judgment rate of this recognition method.

Reference

1. Northeast Electric Power Technology: Wang zhibin, W.Z.B, Analysis and Processing of Bad Data in Electricity Information Acquisition System,33,46-48
2. Big Data of Electric Power: Zhao yongsheng, Z.Y.S. (2019), Research on Real-time Intelligent Analysis, Judgment and Gain of Power Supply Reliability Medium Voltage Blackout Events Based on Big Data Technology,22:3
3. Functional Specification of Electric Power User Information Acquisition System: Zhou hui, Z.H(2013)
4. Power Supply And Power Consumption: Yin xiuyan, Y.X.Y. (2017), Monitoring and Analysis of Repeated Blackouts in Station Area Based on Large Data,1:38-41