Limitation of modes with relay protection

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Abstract

It shown that the model of an undamaged power facility, including a transformer, can serve as an indicator of its damage. Thus, the concept of combining all available information about the controlled object realized. The model represents a priori information about its parameters and at the same time processes the current information about its state. The method of algorithmic models in combination with the method of localization of alternative modes developed in relation to the tasks of adaptive relay protection of transformers and autotransformers. The classification of algorithmic models and methods of monitoring protected objects carried out. A general method for generating protection measurements using an algorithmic model of an undamaged object proposed. An algorithmic model of a transformer with Y0/Δ–11 winding connection developed. For the protection implemented based on this model, effective measurements are determined. The recognizing ability to turn short circuits in the series winding of an autotransformer of three types of differential protection has been studied: traditional design, by negative sequence currents and the proposed adaptive algorithms. The absolute advantage of the latter in terms of recognition ability was established.

Key words: undamaged electrical equipment, transformer, relay protection

Effective operation of relay protective devices (RP) should ensure reliable and stable operation of electric power systems (EPS), eliminate or significantly reduce damage in the event of an accident. Improving the main characteristics of relay protection - selectivity, speed, sensitivity and reliability - is associated with disproportionately lower costs than the corresponding increase in reliability and stability of EPS by improving its facilities and infrastructure. The functions of the relay protection complex include failure in case of internal damage and failure in case of external damage, as well as operation of the protected object and the EPS as a whole in normal and abnormal operating modes. In practice, it can be difficult to ensure the exact performance of the listed functions for all possible operating modes of the protected and measuring equipment, therefore, the concept of operational stability is used to characterize the operation of relay protection devices.

The stability of the relay protection is determined by:

a) stability of destruction during external damage;

b) preservation of sensitivity and set speed in case of internal damage.

Most often, the reason for the disturbance of the stable operation of the relay protection functions is the increase in the error of the measurement part of the relay protection during the transition process (TP) caused by an accident in the EPS. Therefore, the solution to the problem of increasing the stability of relay protection should be aimed at ensuring the required sensitivity and speed of protection in case of internal damage of the protected object and reliable provision of its failure under external influences. The development of the power system requires the installation of power transformers (PT) and autotransformers of larger unit capacity and higher voltage classes. Below, unless otherwise specified in the text, the term "power transformer" also applies to power autotransformers. Damage to the FET can lead to significant destruction of the FETs themselves, and can threaten the stable operation of the EPS as a whole, so FETs must have reliable and effective means of protection.

Recently, interest in such a structure of relay protection has increased and clearly began to increase, which makes it unstable and, moreover, self-regulating. In general, the concept is not new. Thus, it is clearly seen in the famous Bresler relay, the progenitor of the class of polyphase relays. However, if earlier its implementation was heuristic, now it was possible to build a method for recognizing emergency situations of an electrical device based on it. A characteristic feature of the announced method is the isolation of modes that are alternative to controlled ones caused by damage to the protected object, called localization.

The method has applications, but there is a need to generalize and develop existing ideas.
Relay protection is the science of recognizing emergency modes of an observed electrical installation. It is not apparent on the surface, but nevertheless the fact is obvious that recognition should be carried out in reverse order, focusing the main efforts on getting rid of alternative regimes. An electrical device is a part of an electrical system. They are in no way related to the emergency situation of this particular facility, and a strict requirement is imposed on the relay protection in order not to operate in the modes (selection state). In the hierarchy of requirements for the characteristics of relay protection, sensitivity to modes and speed of response to them come after selectivity and are not so categorical. Optimizing relay protection in terms of sensitivity and speed is constrained by strict requirements to ensure selectivity.
The traditional approach to ensuring selectivity is the complete calculation of all elements of the subset and separation from it at the stage of setting parameters, in general - the features of the protection operation. This procedure can legitimately be presented as a protection exercise with a teacher - a simulation model of an electrical system containing a protected object.
Mappings, ideally - to the compression of regions S to a point in each of the measurement planes. A localization tool was found - an algorithmic model of the observed object in its intact state.
The concept of "algorithmic model" was born two decades ago. To date, there is no doubt that algorithmic models have been an effective tool for recognizing the fact and location of damage to an electrical installation (protection and placement problems). At one time, two reasons led to the idea of algorithmic models.
The algorithmic model of the power plant is the transformation of the observed values into measurements. The transformation is performed adequately to real processes when the protected object is not damaged, and inadequately when it is damaged. There is a major difference between the two types of models - algorithmic and simulation. The simulation model covers not only the protected object but also the rest of the system and replicates the system modes. The algorithmic model belongs exclusively to the observed object, is activated by the observed values, and its task is to form the dimensions of the relay protection. The simulation model contains a block of this object. The algorithmic model is structurally adequate for this block, provided that the mode is simulated. For absolute adequacy, the parameters must also match. One way or another, the following regularity manifests itself: in the modes, the algorithmic model is physically adequate to the simulation model, and in the modes it is physically inadequate, because it does not take into account the damage that changes the structure of the block imitating it. protected object.
The main functions of algorithmic models include:
• differentiation of different types of modes explained by the adequacy of the model to the observed object in the β-modes of the electric network and its inadequacy in the α-modes;
• formation of protection measures against exit prices;
• localization of β-mode maps due to adequacy property and correct selection of measurements;
• training of virtual relays by activating the algorithmic model with the signals of the simulation model that reproduces the modes of the given type.
The problem of recognizing a subset of α-modes is solved by using a localization procedure for the subset of β-modes opposite to it.The algorithmic model of an undamaged electrical device acts as a means of localization, which is adequate for it in alternative modes, and inadequate in case of damage. The algorithmic model of an undamaged object is adequate for it in alternate modes, and inadequate in emergency modes. It is here that one can see the physical basis of the localization of alternative modes, the differentiation of different types of modes, and the recognition of the resulting controlled modes.
The electrical quantities observed at the relay protection terminals are converted into measurements, each of which is displayed in its own plane with the operating area or blocking area depicted on it [94]. In general, the hodograph on the measurement plane, which is presented based on the instantaneous values during the observation, describes the mapping location at different points in time. In a certain case, the base

of complex values is used, then the measurement complex is displayed in the complex plane. The real and imaginary parts of the complex are the screen coordinates, in other words, the complex is, by definition, a two-coordinate dimension. This property gives a certain universality to the complex basis, but is not characteristic of the general basis of instantaneous values. At the same time, there is an approach to the construction of algorithms for microprocessor relay protection, which leads to universal presentation of measurements in the form of hodographs of maps as functions of time. The selection of measurements is the content of the method of localization of modes, which are alternative modes of damage to the protected object. Hodographs of appropriately selected measurement displays are localized in alternate modes on a plane in a limited area concentrated near a point or line, their position is determined by ideal conditions for measurement formation.

Ideas about the model of an undamaged object as an indicator of damage are based on physically clear ideas about the two types of modes of the system that includes the observed object - its own emergent modes and all alternative modes, as well as adequacy. the adequacy of the model to the object in alternative modes and inadequacy in its emergent modes.

The recognition of the subset of emergency modes of the protected object is solved using the localization procedure of the subset of alternative modes against it.

The tool for localization of observed modes, alternative modes of damage of a protected power plant is an algorithmic model designed for its undamaged state based on instantaneous or complex values. The concept of complete and incomplete observation of an object in relation to its algorithmic model is introduced, and complete observation is divided into subclasses of maximum, excess, and sufficient observation.

The localization technique is general in nature, subject to full compliance with the protected object. Its main procedures are the formation of two-coordinate measurements using an algorithmic model of an undamaged object and their display in planes.

Structurally, current transformers, like any other transformer, consist of two insulated windings located around a common magnetic circuit. It is made of laminated metal plates, special grade electrical steels are used for melting. This is done to reduce the magnetic resistance in the path of the magnetic fluxes circulating in a closed loop around the windings and reduce the eddy current losses. A current transformer for relay protection schemes and automation can have not one, but two magnetic circuits, differing in the number of plates and the total amount of iron used. This is done to create two types of windings that can work reliably:

1. nominal working conditions;
2. or with significant overloads caused by short-circuit currents.

The first designs are used to carry out measurements, and the second ones are used to connect protections that turn off the abnormal modes that appear.

The windings of current transformers, designed and manufactured for permanent operation in the electrical installation circuit, meet the requirements for the safe passage of current and its thermal effects. Therefore, they are made of copper, steel or aluminum with a cross-sectional area that excludes increased heat. Since the primary current is always greater than the secondary current, the winding for it differs significantly in size as shown in the figure below for a proper transformer.1000 V-a qədər cərəyan transformatorlarının ölçülməsi

The left and middle structures do not have an electrical winding at all. Instead, a hole is provided in the housing through which the power supply wire or stationary bus passes. Such models, as a rule, are used in electrical installations up to 1000 volts.

The transformer winding terminals are always provided with fixed fixing to connect the busbars and connect the wires using bolts and screw clamps. This is one of the critical places where the electrical contact can be broken, which can cause the measurement system to malfunction or fail. During operational checks, attention is always paid to its fastening quality in the primary and secondary circuits. Current transformer

terminals are marked at the factory during production and marked:
• L1 and L2 for input and output of primary current;
• I1 and I2 - secondary.
These indices indicate the winding direction of turns relative to each other and affect the correct combination of power and simulated circuits, the characteristics of the distribution of current vectors in the circuit. During the initial installation of transformers or replacement of faulty devices, attention is paid to them, even before the device is assembled, and after installation, it is checked by various methods of electrical inspections.
The number of turns in the primary W1 and secondary W2 circuits is not the same, but very different. High-voltage current transformers usually have only one straight busbar passing through the magnetic circuit, which acts as a power winding. The secondary coil has more turns, which affects the conversion ratio. For ease of use, it is written as a fractional expression of the nominal values of the currents in both windings. For example, the input 600/5 on the nameplate means that the transformer is designed to enter the circuit of high-voltage equipment with a nominal current of 600 amperes, and only 5 will be converted in the secondary circuit.
Each measuring current transformer is connected to its own phase of the primary network. For relay protection and automation devices, the number of secondary windings is usually increased for separate use in the cores of current circuits:
• measurement tools;
• general built;
• wheel and tire protection.
This method makes it possible to exclude the influence of less critical circuits on more important ones, to facilitate their maintenance and checking of equipment working under operating stress.
During the operation of the current transformer, the balance of the magnetic fluxes generated by the currents in the primary and secondary windings is created. As a result, they are balanced in magnitude, directed in the opposite direction and compensate for the effect of EMF created in closed circuits. If the primary winding opens, then the current will stop flowing through it and all the secondary circuits will simply be de-energized. However, when the current passes through the primary, the secondary circuit cannot be opened, otherwise, under the influence of a magnetic flux in the secondary winding, an electromotive force is created that is not spent on the flow of current in a closed circuit. low resistance, but used in idle mode.
This leads to the appearance of high potentials that reach several kilovolts at open contacts and are capable of breaking the insulation of secondary circuits, disrupting the operation of equipment and causing electrical injury to maintenance personnel.
Conclusion
All the losses in the transformer are losses of active power that occur in the magnetic system, windings and other parts of the transformer under different operating conditions. I also described the advantages of connecting transformers in parallel; we know that it is economical to install smaller rated power transformers in parallel rather than installing larger rated power transformers. In terms of reliability, the presence of a parallel transformer is also preferred. The last part was about basic calculations during operation of transformers in ES. Short circuits or faults can and do occur in electrical power and distribution systems. When a fault occurs on the load side of the transformer, the fault current will flow through the transformer and as components of these systems, transformers must be able to withstand these fault currents. These fault currents through the transformers are much higher than the rated currents of the transformers. From the short-circuit level calculation, we can see how the short-circuit level, i.e., SC power, of the transformer changes if the fault is on different sides of the Transformer. The next example was the voltage drop to show the percentage change in voltage if the transformer is loaded, e.g. according to the

rated power. And from this example we can see that the voltage drops in Transformers too and we have to compensate it by voltage control or tap change. Less power is lost when the voltage is too high, so electric utilities use higher voltages on long-distance transmission wires. However, this high voltage is too dangerous for home use. That's why electrical companies use transformers to change the voltage of electricity. First, the voltage of the electricity from the power plant is brought up to the required level for transmission over long distances through transformers, and then again with the help of transformers, the voltage is reduced before entering our home. I decided to research transformers because they have become an integral part of our daily life.

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