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THE ISSUES OF PHILOSOPHY IN RELAY PROTECTION

Философия (греч.) – дословно «любовь к мудрости», изучает наиболее общие принципы реальности. Википедия определяет философию, как науку, изучающую все. Логика и критический анализ являются столпами философского мышления. Почему бы не применить эти атрибуты философии к анализу ситуации в релейной защите – задался вопросом канд. техн. наук Владимир Гуревич. Оказалось, что такой анализ может привести к парадоксальным выводам.

Ключевые слова: *философия, релейная защита, реле защиты, аварийный режим, микропроцессорные устройства релейной защиты*

The life of a modern person is closely related to the use of complex and inter-connected systems such as cellular communication, television, radio, electric systems and others. All these systems can be visualized as a so called “consumer chain”, which consists of series of links. The last link in this chain, i.e., the one that directly interacts with a person would be a certain apparatus (terminal): cellular phone, TV, radio receiver, refrigerator, washing machine, etc. The aspiration to improve the last link (in other words the one that actually interacts with a person) and make it perfect, even though all other links may be far away from perfection is clear and justified. A special design of a TV-set, its user -friendliness, special functions (such as, record and playback telecasts according to a specific schedule; playback CDs; split screen that allows having a main screen and a series of auxiliary screens, making it possible to watch several channels simultaneously, etc.) adds significant value to such a TV-set from the stand point of the consumer, regardless the fact that this TV-set is only a final link in a long chain called television. It does not mean that the quality of TV programs or the quality of broadcasting will be of the same quality (perfect) as the final link. However, this doesn’t prevent a rich consumer from investing in an expensive (perfect) final link. Likewise, poorer consumers do not stop dreaming about this perfect final link. Thus, the final link in different consumer chains has a special status and certain requirements and attention are accorded to it by both consumers and manufacturers. On the other hand, regardless of the perfection of the final link, it cannot influence the quality or reliability of the chain in general. Indeed, a broken TV-set in one of the rooms in the consumer’s house will not influence the operation of TV-sets in other rooms, or the neighbors’ TV-sets.

Another feature of the final link of the above mentioned the consumer chains is the applying of customer requirements to functionality and design beyond requirements of reliability and longevity. This is conditioned by modern trends, when substitution of one final link by the other has not much to do with malfunctioning or breakage, but with technological obsolescence and the emergence on the market of new models with better functions and improved design.

Now, let us compare this situation with what happens in relay protection (RP), which is the most important component of a consumer power supply circuit that consists of a series of links called production, transmission and distribution of electric energy. Where is the place of relay protection in this circuit? Surprisingly, there is no such link in this chain! Indeed, relay protection neither participates nor influences the operation of the circuit under normal mode of consumer chain operation. RP does not influence the amount of produced energy. Nor does it influence the capacity of energy transmitting lines or the process of energy distribution. Relay protection can even be

disconnected from energy supply circuit and there will be no effect on the circuit's operation. So, what is relay protection and where is its place in energy transmission and distribution circuit? Visually relay protection can be depicted in this chain as a set of separate auxiliary links installed in the places of connection of main links of the energy supply circuit, i.e., production, transmission and distribution of electric energy, Fig. 1.

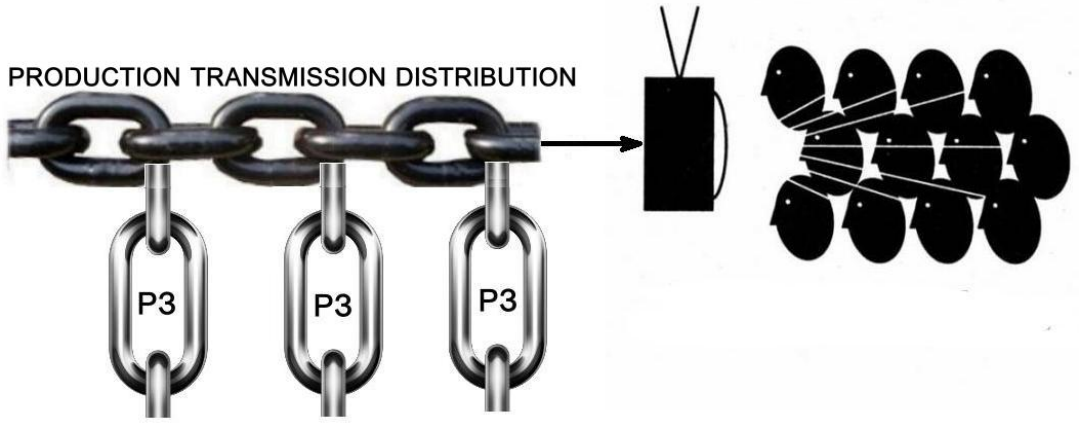


Fig. 1. Visualization of a consumer chain of power supply equipped with relay protection (RP)

Functionally, these places of connection are formed by high-voltage switches, the condition of which is determined by relay protection. In other words, even though relay protection is not a series link in the power supply circuit, it can influence the connectors between the links (by circuit breakers) by cutting the ties between all the links of this chain. This is a fundamental difference of relay protection from other links in consumer chains.

If relay protection does not influence the power supply circuit under its normal mode of operation, does it have any effect under the emergency mode? It is widely perceived that this influence consists in the prevention of emergency modes in the power supply circuit. Is this really so? To answer this question we need to understand what relay protection is and what its functions are. Let us review publication [1], which provides a detailed analysis of this issue based on which we obtain such concepts as "protective relay" and "relay protection":

Protective relay *is a device, the purpose of which is to detect the emergency mode of the object being protected and send a command to a control power element, which eliminates this mode.*

A system of relay protection *is an aggregate of related devices, which ensure detect of the emergency mode in the operation of electric equipment and its elimination.*

These definitions show that regardless of the widespread opinion that an RP cannot *prevent* the emergency mode in a power supply circuit, it can limit the scale of its effect on this circuit in time and space, in other words, limit the material damage from the break-down and nothing more.

Everything said above is related to a properly functioning relay protection and its correct operation. But as many other complex technical devices relay protection can also malfunction. This creates an absolutely different situation, where a malfunctioning relay protection due to a so called "unnecessary protection operation" can send a faulty command to open a circuit breaker (in other words, break ties between the links of a power supply circuit) thus creating an artificial prevention of normal functioning of a power supply circuit, i.e., its switching to an abnormal, emergency mode, leading to the disconnection of thousands of consumers and great damage.

This makes us conclude that relay protection ***cannot prevent an emergency mode*** *of operation of a power supply circuit, but it* ***can cause this mode.***

Recently significant qualitative changes have happened in the field of relay protection. Single function electro-mechanical protection relays have been replaced by multi-functional digital protective relays (DPR) with much higher qualitative characteristics and easily programmable logic. How does perfection of characteristics and improved functional capabilities of the new protection relays influence the operation of power supply circuit? As mentioned above, there is no influence

under the normal mode of operation. However in the case of emergency mode in the circuit the DPR can efficiently limit its effect in time and space due to their improved characteristics, in other words they are more effective in limiting the material damage than electro-mechanical protection relays.

At the same time it is known [2] that DPR are less reliable than electro-mechanical protection relays (we are talking about the best electro-mechanical relays manufactured by the leading Western companies);. Their lifetime does not exceed 15-20 years. They are more susceptible to destructive external impacts, such as cyber attacks or intentional electro-magnetic impact. A lot of functions in one terminal, some additional functions of DPR not specific to relay protection and mistakes of staff during free programming of logics reduces reliability of relay protection even further and increases the probability of malfunctioning, i.e., resulting in such impacts on the power supply circuit that lead to deterioration of its operation (emergency modes).

Thus, transition from electro-mechanical protection relays to DPR results in reduction of material damage from accidental emergencies in the power supply circuits, but at the same time it leads to an increase in the number of accidents (due to additional accidents caused by the malfunctioning of relay protection device itself) in the power system. To support this, let us quote [3], which provides a general picture of the situation:

«Conventional electro-mechanic relay protection, like all domestic low-voltage equipment is reliable and long-lasting, which corresponds to the main principle of a renowned Austrian company of Paul Hertz: 'All types of electro-technical equipment must operate more than 50 years'. It is noteworthy that the unique power plant of Russia has been working without system outages for 50 years. In the course of reformation of electric power sector the philosophy of relay protection and automatics (RPA), where mostly electro-mechanical and microelectronic devices produced by Cheboksary Electric Apparatus Plant have been used, is reviewed now. Technical re-equipment of protection presupposes implementation of microprocessor RPA, produced mainly by foreign companies. This decision rests on the positive experience of implementation of microprocessor-based devices abroad. But it should be remembered that user friendly and multi-functional foreign equipment has its specific features. According to International power organization, which dates back to the time of full-fledged socialism (SIGRE) and the Soviet scientist Venikov V.A., system outages are regular in the power industry of many countries where equipment of companies sharing the Russian market has been used and is used now.

Unlike the trouble-free operation of the Unified electric power system of Russia, which is protected by electro-mechanical relays, there were 13 major accidents abroad during the last two decades and 8 of them were in the USA. Power supply failures covered large territories, whereas Russian equipment continues functioning faultlessly in Egypt, Iran and Africa. There were neither breakdowns nor failures at power plants.»

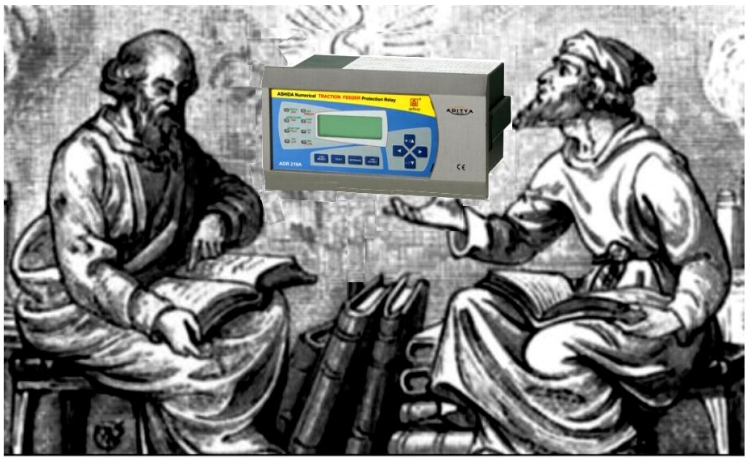
Taking the above into consideration, we come to the conclusion that *unlike consumer chains mentioned in the beginning of this article, reliability and longevity of relay protection in the power supply circuits should prevail beyond improved characteristics, expanded capacity and design.* Specifically we come to the following conclusions:

1. The promoted advantages of DPR compared with electro-mechanical protection relays are insignificant and have little influence on general efficiency of a power supply circuit.

2. The efforts of DPR developers and manufacturers should be mostly concentrated on improving reliability of devices and their resistance to intentional external impacts, not to increasing the number of functions, perfection of characteristics and design.

3. When comparing and evaluating DPR quality and selecting a certain type of DPR, reliability and resistance to external impacts should prevail beyond the number of functions and quality of their characteristics.

4. It is necessary to develop simple, clear and efficient methods of evaluation of DPR reliability [4] and arrange collection of real data about failures.



REFERENCES

1. Gurevich V. I. Protective relay" and "Relay Protection: Problems with the Terms. – Electric Power's News, 2012, N 4, p.p. 23 – 33.

2. Gurevich V. I. Digital Protective Relays: Problems and Solutions. – CRC Press (Taylor & Francis Group), Boca Raton – New York – London, 2010, 404 p.

3. Usova S. V. A "Bright Tomorrow" Will Predict by Dollar Exchange Rates. – Russian Power and Industry, No. 8 (24), august 2002.

4. Gurevich V. I. A New Criterion Need to Evaluate Reliability of Digital Protective Relays. – Energy saving. Power engineering. Energy audit. – 2012, No. 3, p. 63–70.

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Philosophy beginning with the ancient Greeks is literally "a love of wisdom" and deals with the most general issues of reality. The Wikipedia dictionary determines philosophy as a science, which studies everything. Logic and critical analysis are the pillars of philosophic thinking. 'So, why don't we use these attributes of philosophy to analyze the situation around relay protection,' – Dr. Vladimir Gurevich raises this question, and it appears that such analysis may result in counterintuitive findings.

Keywords: *philosophy, relay protection, protective relays, emergency mode, digital protective relays.*

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