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ADVANTAGES AND DISADVANTAGES OF LOCAL METHODS OF DETERMINING THE POINT OF SINGLE-PHASE GROUNDING ON 6-35 KV LINES INSULATED FROM NEUTRAL GROUND

This article analyzes the characteristics of single-phase ground faults in 6-35 kV overhead transmission lines and analyzes methods for determining the location of single-phase short circuits in our power system. The advantages and disadvantages of single-phase grounding methods used in the energy supply of the country are considered.

Key words: Power overhead transmission lines, cable lines, abnormal modes, single-phase grounding, remote detection of the point of damage.

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ПРЕИМУЩЕСТВА И НЕДОСТАТКИ ЛОКАЛЬНЫХ СПОСОБОВ ОПРЕДЕЛЕНИЯ ТОЧКИ ОДНОФАЗНОГО ЗАЗЕМЛЕНИЯ НА ЛИНИИ 6-35 кВ, ИЗОЛИРОВАННЫХ ОТ НЕЙТРАЛЬНОГО ЗАЗЕМЛЕНИЯ

В данной статье анализируются характеристики однофазных замыканий на землю в воздушных линиях электропередачи 6-35 кВ и анализируются методы определения места однофазных замыканий в нашей энергосистеме. Рассмотрены преимущества и недостатки однофазных способов заземления, применяемых в энергоснабжении страны

Ключевые слова: воздушные линии электропередачи, кабельные линии, нештатные режимы, однофазное заземление, дистанционное обнаружение места повреждения.

The relevance of the problem discussed in the paper is stipulated by the risk of electric shock for people and animals near 6-35 kV overhead lines. It is necessary to find the short circuit location in distribution networks in the shortest possible time. Inspection of extensive, branched and hard-to-reach overhead sections takes a lot of time, so it is easier and quicker to use special portable devices for search of ground fault location. As operating experience shows, search devices produced in Russia fail to determine location of “non-metallic” single-phase damage. The aim of this study is to identify the causes for failures of existing portable devices and to develop new ways of searching short circuit location. For this purpose, operation of 6-35 kV distribution network at different single-phase faults is analyzed. An equivalent circuit of the studied distribution network has been developed during the analysis. The authors have also completed a series of calculations of tension and currents of different harmonic components in network branches at different types of single-phase damages. They have studied the influence of resistance change in the place of short circuit on harmonic tension and current components and estimated emission of electromagnetic field under real overhead wires of the studied network at artificial single-phase damages. Cumulative amplitude-phase analysis of the highest harmonic current and tension components enables development of a new way of searching for ground fault location in the extensive 6-35 kV overhead distribution network. The main reason of failure of portable searching devices appears to be a level in-time variation of the highest harmonic current components [2].

In order to prevent possible accidents in the power system of the Republic and to ensure the stability of the power system, 110-500 kV transmission lines, 6-35 kV distribution lines and 0.4 kV low-voltage power lines are allocated [1]. In the power system of our country, the supply of distribution substations 35-110 / 6-10 kV is carried out mainly through overhead transmission lines, the general characteristics of these medium-voltage networks and the current state, we can see below [2, 3, 4]:

- Substations of 35-110 / 6-10 kV (expired) and relatively obsolete technical and mechanical condition make up 70% of the total distribution network in the country [4];
- The management system of substations are implemented without the participation of a permanent duty officer [5];
- Substation and distribution lines are located at a distance from the control point and each other (except for the power supply of cities and industrial facilities):
- The lines that run out of substances, unlike urban and industrial facilities, consist mainly of overhead lines. Due to the long distance of consumers from their supply substations, abnormal modes such as damage or overload of 6-35 kV power transmission lines occur, their elimination time is long and therefore many adverse events are observed;

In contrast to rural power supply, urban and large industrial enterprises are relatively convenient to operate due to the short length of supply lines for shops and other departments from several substations (proximity and mainly the use of cable lines). Reduces the time to identify the location of the injury and repair it).

However, the operation of agricultural overhead transmission lines is a bit more complicated. For example, if a single-phase ground fault (6-35 kV networks) occurs in a feeder, a small operational team will be required to inspect each line according to the schedule. In general, accidents on 6-35 kV transmission lines can be divided into two groups: natural-climatic [6] and accidents caused by exploitation [6, 2].

According to today's statistics, single-phase ground faults on 6-35 kV transmission lines, which account for 75% of the total damage, are a dangerous problem [4].

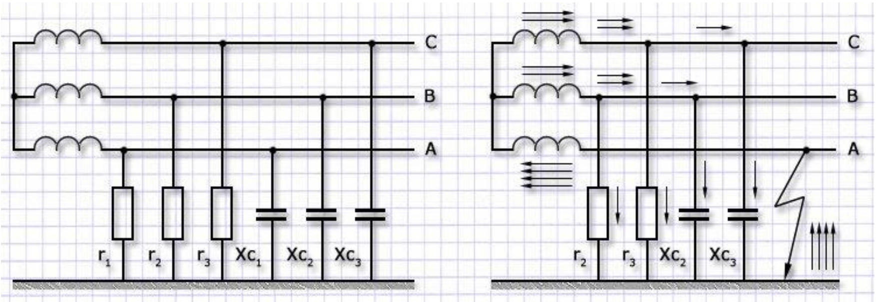
Rapid detection of single-phase grounding and thus taking measures to ensure long-term disconnection of electricity consumers is a topical issue today.

In general, it is not possible to detect single-phase ground faults in 6-35 kV neutral insulated or compensated overhead lines in a timely manner and to locate the fault using conventional relay protection and automation devices [7]. Due to the fact that the connection group of 6-10 kV overhead lines is connected by Δ/Δ method, the method of determining the short-circuit location of single-phase grounding used in high-voltage lines, as well as the use of installed devices is inefficient.

Therefore, it is advisable to inspect the entire line using portable electrical devices [8] to determine the point of damage. Remote location of damage on overhead transmission lines is usually done when the line is off. Such detection methods are divided into the following groups:

- impulsively,
- wavy
- nodal [8].

There are a number of limitations to all methods. For example, the pulse method is applied to only one dead line, the wave method is used for cable lines and tested under high voltage, the node method is tested on both sides of a single dead line [9]. New methods for determining the location of a single-phase grounding device are currently being actively used in overhead lines [7] that are sensed by the electromagnetic field around the line [10], but the detection of a single-phase grounding is still relevant.



Pic.1.Schematic diagram of single-phase grounding on 6-35 kV lines

To reduce the time of emergency response, the method of remote single-phase ground detection is widely used today.

The following factors should be taken into account when using the method of remote detection of single-phase grounding on 6-10 kV overhead transmission lines and the use of electrical equipment:

a) Large length and branching of lines;

b) Difficulty shutting down in the event of an injury;

Restrictions on power supply modes are introduced to prevent electrical equipment failure or overvoltage due to the risk of single-phase grounding;

1. Neutral mode in networks;
2. Inability of the operative inspectors to carry out on some parts of the air lines

The operative inspectors receive a single-phase ground signal, perform measurements to determine the location of the connection, and perform search operations. The following work is performed to determine the location of a single-phase ground connection on an overhead transmission line:

In this case, the mode of remote location of damage on overhead transmission lines involves the implementation of the following sequences [4, 8]:

1) records data on single-phase grounding (unselective signaling);

2) identify the damaged line;

3) Identify the damaged section of the line (distance)

4) Determines the point of injury (topographic or OMP along the way).

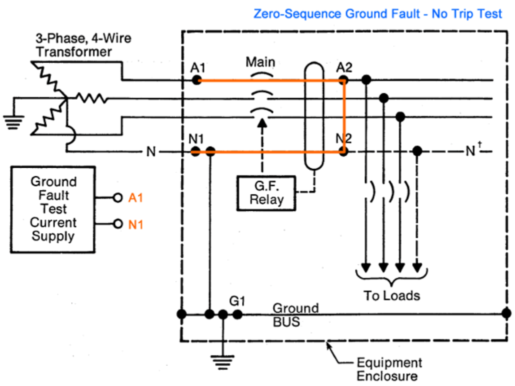
5) The non-selective signaling device records the single-phase ground connection generated in the line:

a) This reduces the insulation resistance; The phase voltage between the damaged line and the ground decreases;

b) A zero sequence voltage is occured [7, 8];

c) The detection uses the sequence of deleting lines;

d) When the faulty line is disconnected, the zero-sequence voltage is lost (or the ground phase voltage is restored).



Pic.2. Zero-Sequence Ground Fault No Trip Test Example Test Procedure

There are a number of shortcomings in identifying a damaged line by deleting such a series of lines:

Shutdowns can cause power outages on power lines;

1. As a result of switching overloads, the probability of switching from single-phase short circuit to multi-phase short circuit mode increases.;
2. Prolonged search of the injured area and the availability of pay for staff

The listed shortcomings are not present in selective protections against single-phase grounding (selective synchronization devices). All received selective signaling devices [8, 11, 12] can be divided into the following groups:

a) Zero-sequence components of industrial frequencies,
b) Installed single-phase grounding harmonic components,
c) Single-phase grounding is a free transient process.

The use of selective signaling devices for maintenance and repair of existing 6-35 kV distribution lines is yielding good results. In particular, the selective signaling devices used in developed countries can be divided into the following groups:

1. 100 Hz high harmonics were used,
2. to a loaded current with a frequency of 25 Hz,
3. to the emergency components of the symmetry of current and voltage,
4. Signaling devices based on the use of current and time feedback characteristics.

In conclusion, I am sure that the widespread use of modern and advanced electrical measuring devices and operating principles used by developed countries in the energy supply of our country will be very effective in eliminating the most common injuries in our power grids. . Determining the location of single-phase earthling, which is often observed, especially in 6-35 kV transmission lines, and taking measures to eliminate it effectively, will allow to provide quality electricity to consumers, as well as reduce electricity losses.

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