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Testing of over current relay (OCR) as a protection equipment in electrical power systems

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Abstract

The development of today's technology, the availability of electrical energy must be met very well. Because we already know that almost all human activities require electrical energy. In an electric power system, this energy is produced by a generator driven by a prime mover so that it can produce electrical energy. The propulsion can come from water, steam, geothermal and others. So from that initial mover we can call it PLTA (Hydroelectric Power Plant), PLTU (Steam Power Plant), PLTP (Geothermal Power Plant), and others. From the generator, the electrical energy is sent through the transmission network after it is connected to the distribution network, from the distribution network the energy is distributed to consumers. To meet the reliability of the availability and distribution of electrical energy, the need for an adequate protection system is absolutely necessary. The function of the protection system equipment is to identify disturbances and separate the disturbed network part from other parts that are still in normal condition and at the same time secure this part from damage that can cause greater losses. Overcurrent relay is a safety relay that works because of the amount of current and is installed on a high voltage network, medium voltage is also on the power transformer safety. This relay serves to secure electrical equipment due to phase disturbances.

Keywords: Electric power system, Protection System, Over Current relay (OCR)

1. Introduction

During the development of current technology, the availability of electrical energy must be met very well. Because we already know that almost all human activities require electrical energy. In an electric power system, this energy is produced by a generator driven by a prime mover so that it can produce electrical energy. From the generator, the electrical energy is sent through the transmission network after it is connected to the distribution network, from the distribution network the energy is distributed to consumers.

The electric power network generally consists of generators, transmission lines, substations and transmission lines, and distribution networks. Distribution of electrical energy requires a protection system that has reliability in identifying disturbances.

The function of the protection system equipment is to identify disturbances and separate the disturbed network part from other parts that are still in normal condition and at the same time secure this part from damage that can cause greater losses.

The protection relay as one of the equipment in the protection system is a device that works automatically to regulate/enter a signal rangkat listrik (rangkaian trip atau alarm) akibat adanya perubahan lain yang then give orders to the power breaker (PMT).

The purpose and objective of installing a protection relay is to identify disturbances and separate the disturbed network parts from other parts that are still healthy and at the same time secure the healthy parts from damage or greater loss, by:

1. Detects interference or other abnormal conditions that may harm equipment or systems.
2. Removing (separating) parts of the system that are disturbed or experiencing other abnormal conditions as quickly as possible so that damage to installations that are disrupted or through which fault currents pass can be avoided or limited to a minimum and other system parts can still operate.
3. Provide backup security for other installations.
4. Provide the best electrical reliability and quality services to consumers.
5. Securing humans against the dangers posed by electricity.

2. Testing Method

2.1 Protection System

The function of the protection equipment is to identify disturbances and separate the disturbed network parts from other parts that are still healthy and at the same time secure the healthy parts from damage or greater loss. The Protection System must meet the following requirements:

- **Sensitive**

That is able to feel the slightest disturbance. A protection relay is in charge of securing a device or a certain part of an electric power system, tool, or part of the system that is included in its security range. The protection relay detects a fault which occurs in the security area and must be sensitive enough to detect the disturbance with minimum stimulation and if necessary only trip the circuit breaker (PMT) to separate the disturbed part of the system, while the healthy part of the system in this case should not be open.

- **Reliable**

That is, it will work when needed (dependability) and will not work when it is not needed (security). Under normal conditions or systems that have never been disturbed, the protection relay does not work for months, maybe years, but the protection relay if needed must and must be able to work, because if the relay fails to work it can cause more severe damage to the equipment being secured or result in the operation of another relay so that the area experienced a wider blackout. To maintain its reliability, the protection relay must be tested periodically.

- **Selective**

That is able to separate the network that is disturbed only. The selectivity of the protection relay is a quality of careful selection in holding security. The exposed part of a system due to disturbance must be as small as possible, so that the disconnected area becomes smaller. The protection relay will only work during abnormal conditions or disturbances that occur in its security area and will not work under normal conditions or in conditions of disturbances that occur outside its security area.

- **Hurry**

That is able to work as quickly as possible. The faster the protection relay works, it can not only reduce the possibility of interference, but can reduce the possibility of widespread effects caused by interference. Disrupted power grids must be immediately identified and separated from the rest of the network as quickly as possible with the intention that greater losses can be avoided. Disturbances in the electric power system can occur on the generating, network and distribution side.

- **Sensitive**

That is able to work sensitively in following the existing conditions. The more sensitive to interference, the better protection

- **Economical**

The protection system has a high economic value in terms of protection resistance so that it can be used for a long time and is easy to maintain.

2.2 Security area

In the application of the protection system of the Electric Power System, there are known safety areas. Each safety area generally consists of one or more security equipment from the electric power system. The safety zones are made in such a way that they overlap each other as shown in the image below.

Each zone has a certain protection pattern and each pattern has a certain protection system, with layered protection. Therefore there is Main Protection and Backup Protection. Backup protection methods can be classified as follows:

1. Back-up relay
2. Breaker backup
3. Remote Backup
4. Centrally coordinated backup
5. Duplicated Relay

2.3 Short Circuit

If the isolation system in the electrical power system installation fails to perform its function or there is a contact connection through a conductive foreign object, a short circuit will occur. Phenomena that occur during a short circuit include the voltage and current in each phase becoming asymmetrical and the current flowing in the disturbed phase will increase.

1. This short-circuit fault current is contributed by all generators in parallel with the system, then flows through the installation (Power Transformer, Transmission) to the fault point. With
2. Thus, all installations through which the short-circuit fault current passes will feel the effects of the short-circuit.
3. The magnitude of the fault current is determined by:
    1. Source Voltage
    2. System Impedance (MVA short circuit)
    3. Interference Impedance
    4. Types of short circuit fault
        - 3-phase short circuit
        - 2 phase short circuit
        - 2 phase short circuit to ground
        - 1 phase short circuit to ground

This fault current will cause electrodynamic forces and generate high heat in the installation in its path. The magnitude of the electrodynamic force suffered by the installation depends on the magnitude of the short circuit peak current, while the temperature that occurs depends on the magnitude of the symmetrical fault current and the duration of the short circuit. In this condition the Protection Relay will play its role.

2.4 How the Protection Relay Works

Relay is a device that works automatically to regulate / enter an electrical circuit (trip circuit or alarm) due to other changes. Derived from the technique of telegraphy, where a coil is energized by a weak current. And this coil pulls the armature to close the contacts. Relays are an important part of TL system protection, and have developed into complex equipment.

Relays are distinguished in two groups:

1. Comparator, detects and measures abnormal conditions, and opens/closes contacts (trips)
2. Auxiliary Relays, designed for use in auxiliary circuits

controlled by comparator relays, and opening/closing other contacts (which are generally strong current)

2.5 Device Protection System

Protection consists of a set of equipment which is a system consisting of the following components:

1. Relay, as a sensing device to detect a disturbance which then gives a trip command to the Power Breaker (PMT).
2. Current transformer and/or voltage transformer as a device that transfers primary electricity quantities from the secured system to Relays (secondary electrical quantities).
3. Power breaker (PMT) to separate the disturbed part of the system.
4. Batteries and chargers as a source of power for the operation of the relay, triping aids.
5. Wiring consisting of secondary circuits (current and/or voltage), triping circuits and auxiliary equipment circuits.
6. Broadly speaking, the protection relay consists of three main parts, as shown in the block diagram (Fig. 1), below:

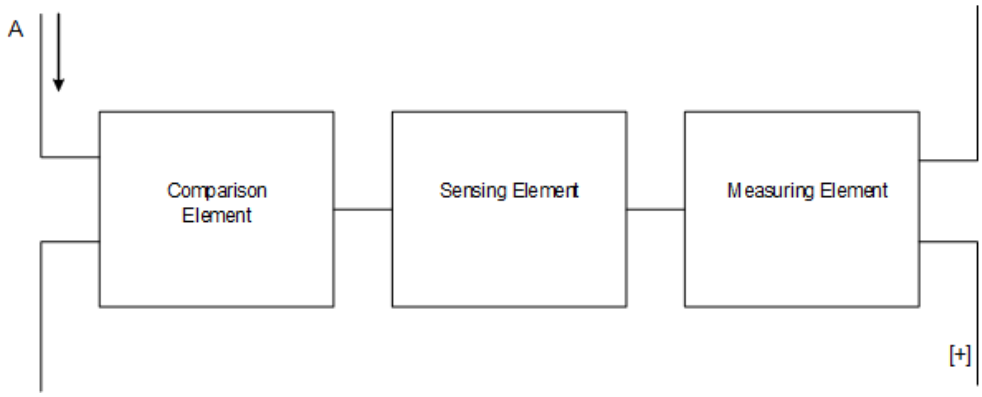

Fig 1: Main block diagram Protection relay

Each element/section has the following functions

Sensing element

This element functions to sense electrical quantities, such as current, voltage, frequency, and so on depending on the relay used.

In this section, the condition of the incoming quantity will be felt, whether the protected condition is disturbed or in normal condition, then the quantity is sent to the comparison element.

Comparison element

This element functions to receive a quantity after the element is first received by the sensing element to compare the electrical quantity under normal conditions with the RELAI working current.

Measuring/determining elements.

This element serves to make changes quickly to the size and will immediately give a signal to open the PMT or give a signal.

In the protection system using a secondary protection relay (figure 2), it is described as follows:

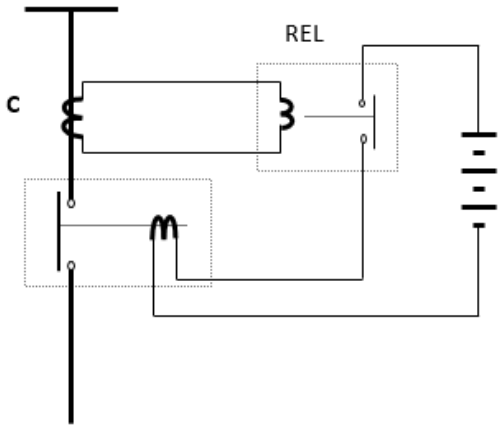

Fig 2: Secondary protection relay circuit

Current transformer (CT) functions as a sensing device that senses whether the protected state is in normal condition or under disturbance. As a comparison tool as well as a measuring device is the relay, which works after getting the magnitude from the sensing device and comparing it with the adjustment current of the relay. If the amount is not balanced or exceeds the setting current, the relay coil will work to pull the contact quickly or with a time delay and give orders to the trip-coil to work to remove the PMT. As a source of energy / propulsion is a direct current source or battery.

3. Results and Analysis

3.1 Overcurrent Relay (OCR) Working Principle

Overcurrent Relay is a relay that works against overcurrent, this relay will work when the current flowing exceeds the current setting value (I sett). This relay works by reading the

input in the form of current and then comparing it with the setting value, if the current value read by the relay exceeds the settig value, the relay will send a trip command (release) to the power breaker (PMT) or circuit breaker (CB) after a time delay. Applied to the settings.
Overcurrent Relay – OCR protects electrical installations against interphase faults. Meanwhile, to protect against ground faults, the Ground Fault Relay (GFR) is used. The working principle of GFR is the same as OCR, the only difference is in the function and current sensor elements. OCR usually has 2 or 3 current sensors (for 2 or 3 phases) whereas GFR has only one current sensor (single phase).

3.2 Aims and Objectives
The purpose and objective of the test is to obtain the working current of the relay (pick up and drop off current) and the working time characteristics of the numerical type of overcurrent relay. The type of overcurrent relay tested is MCGG52.

3.3 Setting and Testing
Before being tested, the relay must first be set (in settings). Setting the relay depends on the brand and type of each. In general, the things that need to be set are work flow and working time. For instantaneous relays, the working time does not need to be set because it is definitely close to zero.
Below is an example of how to set up and test an electro-mechanical overcurrent relay.

3.4 Menyetel Relai Arus Lebih
- **Setting Is Current (with time delay)**

Is = K.IN. Where
ls = Relay nominal current, this current has two values which are multiples, for example: 2.5A (Series) and 5 A (parallel)
K = Factor depending on the manufacturer: for example: 1 to 2. Ada juga arus nominal Relai hanya mempunyai "satu besaran dan faktor K. berkisar antara 0,05 sampai dengan 2,4 dengan step 0,05.

- **Setting Relay working time**

For a certain time relay setting the relay working time can be carried out directly according to the desired time.
Ihs = short-circuit current in the system when viewed from the secondary side of the CT. (same as the current entering the relay).

- **Set current for instantaneous overcurrent relay.**

Is (Moment) = K. IN or
Is (Moment) = K. Is
Where: IN = Relay nominal current
Is = current setting (time delay)
K = 3 to ~ (infinity).

3.5 Relay Data
Type: OCR
Type: MCGG52
Type: GEC ALSTHOM

Fig 3: OCR MCGG52

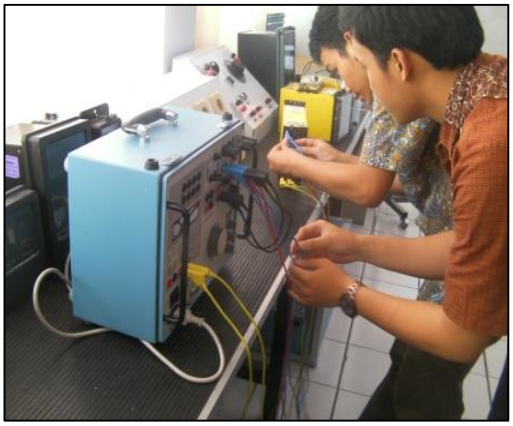

Fig 4: Testing the OCR Relay with Sverker

4. Conclusion
The conclusions that can be drawn from the tests that we carried out at PT PLN (PERSERO) Udiklat Central Java are:

1. The protection system consists of equipment CT, PT, PMT, dc/ac power supply, relay protection, teleprotection integrated in a series of wiring
2. The protection system must meet the following requirements:

- Sensitive
- Reliable
- Selective
- Fast
- Sensitive
- Economical

3. Relay is a device that works automatically to regulate/enter an electrical circuit (trip or alarm circuit) due to other changes. Derived from the technique of telegraphy, where a coil is energized by a weak current. And this coil pulls the armature to close the contacts. Relays are an important part of TL system protection, and have developed into complex equipment.
4. Broadly speaking, the part of the protection relay consists of three main parts

- Sensing elements.
- Comparative elements.
- Measuring/determining elements.

5. Overcurrent relay serves to secure the transformer against short-circuit faults between phases inside and outside the transformer safety area
6. Overcurrent relay is a relay that works against overcurrent, this relay will work when the current flowing exceeds the current setting value (I sett). This

relay works by reading the input in the form of current and then comparing it with the setting value, if the current value read by the relay exceeds the settig value, the relay will send a trip command (release) to the power breaker (PMT) or circuit breaker (CB) after a time delay. Applied to the settings.

7. This relay serves as a safety against short-circuit current disturbances of phases and ground phase can be used as:

- Feeder main protection (medium voltage network)
- Backup protection for transformers, generators and transmissions
- The main safeguard for small and radial power systems.

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