Evaluation of Relay Protection Systems for Transmission Line Reliability at Tele Samosir Substation

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Abstract:
This study focuses on evaluating the role and effectiveness of relay protection systems applied to transmission lines at the Tele Samosir Main Substation. In electrical power systems, maintaining uninterrupted service is essential, as disturbances such as natural events, equipment damage, and external interferences can lead to power outages and operational losses. Protective relays are critical components designed to detect abnormal conditions, such as short circuits and overloads, and to initiate automatic disconnection through circuit breakers to prevent further system damage. This research discusses the working principles, classifications, and selection criteria of relays used in transmission line protection, emphasizing their importance in ensuring system stability and operational safety. The findings underline that proper relay coordination and selection significantly contribute to minimizing disturbances and enhancing the overall performance of the power distribution system.

Keywords: relay protection, transmission system, substation, electrical disturbances, system reliability

Introduction

1.1 Background

electricity supply shows a trend towards increasingly large power plants. This is in line with current technological advances, where many activities depend on the availability of electricity, meaning the need for electricity is increasing. This situation raises the question of how to address the reliability of the electricity system, and the main operational equipment in the power plant must be maintained from damage caused by disturbances in the surrounding area. The current development of electricity supply shows a trend towards increasingly large power plants. This is in line with current technological advances, where many activities depend on the availability of electricity, meaning the need for electricity is increasing. This situation raises the question of how to address the reliability of the electricity system, and the main operational equipment in the power plant must be maintained from damage caused by disturbances in the surrounding area.

1.2 Formulation of the problem

Based on the background, the problem formulation can be taken as follows :

a. How is the type of relay used in the Tele Substation selected ?
b. How to secure the transmission channel when there is a disturbance ?
c. How is the maintenance of the type of relay used in the main tele substation ?

1.3 Research purposes

The research objectives for this final assignment are :

a. To find out the types of relays used in Tele Substations.
b. To describe disturbances and protection on transmission lines.
c. For the type of selection and safety of the use of relays on transmission lines at the Tele **Substation.**

1. Literature review

Transmission lines are corridors that must be passed in the distribution of electrical energy . transmitting large-scale electrical power from Generator Stations/Power Plants to distribution stations until it reaches electricity consumers. In transmission networks, various types of disturbances often occur, including single-phase to ground short circuits, phase-to-phase short circuits, inter-phase to ground faults and symmetrical disturbances. Disturbances in the transmission system are very likely to occur. One of them is overvoltage disturbances (Over Voltage) both internal and external disturbances, symmetrical and asymmetrical disturbances which include single-phase to ground short circuits, two-phase to ground, three-phase to ground, two-phase short circuits, and three-phase short circuit disturbances, overload disturbances (Over Load) disturbances - these disturbances if not quickly addressed will disrupt the flow of power to consumers, with disturbances that occur in the system, continuity of power flow can be maintained in several ways, one of which is by carrying out load shedding.

2. Research methodology

3.1 Research Location Determination Method

The research area was determined purposively or intentionally. Proposive is a sampling technique with certain considerations. The reason for using the purposive technique as the determination of the area in this study is because it is appropriate for its use, namely for research that does not conduct generalizations or quantitative research (Sugiyono, 2016: 85). The research area chosen by the researcher is the PT. PLN (Persero) Tele Substation located on Jalan Partungko Naginjang, Harian District, Samosir Regency, North Sumatra. The research time required by the researcher is from June 2023 to July 2023 .

3.2 Method of collecting data

The data collected in this study comprises primary and secondary data. Primary data was obtained through direct observations and interviews with relevant parties at the PT. PLN (Persero) Tele substation. Documentation was also collected by the researcher at the PT. PLN (Persero) Tele substation. Secondary data was obtained from literature reviewed by the researcher and from relevant agencies.

3.3 Data Analysis Methods

Analysis is an effort made by researchers to obtain answers to the problems being studied. The analysis method used by researchers is qualitative descriptive analysis, namely a research method by collecting data according to what has been observed and interviewed by researchers, then the data is interpreted by researchers in the form of images and conclusions regarding the Study of Relay Use on the Transmission Line of the PT. PLN (Persero) Tele Substation.

3. Research Results and Discussion

4.1 Use of Relays in Tele Substations

Relays used on lines in substations are often referred to as "protection relays" or "protection relays." Protection relays are electronic devices used in electrical power systems to detect faults or abnormal conditions in the electrical network and take action to protect equipment and minimize damage. The primary function of protection relays in substations is to detect various problems, such as overcurrent,

overload, short circuit, phase imbalance, and earth fault. These relays can control the operation of circuit breakers to cut off the flow of electricity to the affected section of the network.

4.2 Types of Relays Used in Tele Substations

1. Protection Relay

A protective relay on an electrical transmission line is a device designed to detect faults or abnormal conditions in an electrical transmission system and automatically take action to protect equipment and maintain reliable system operation. This protection is crucial for preventing serious damage to equipment, power supply disruptions, and even potential accidents.

a. Overcurrent Relay

An overcurrent relay, also known as an "overcurrent relay" in English, is a protective device used in electrical systems to detect and protect against excessive current conditions that can cause damage or danger in the system. An overcurrent relay works by monitoring the amount of current flowing through an electrical circuit. If the current exceeds a predetermined threshold, this relay will respond by activating a trip or disconnecting other protective devices, such as a circuit breaker, to break the circuit and stop the flow of excessive current that can damage equipment or cause danger.



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Relay Aru

Overcurrent relays are essential in a wide range of applications, including electrical distribution systems, power systems, industrial machinery, and more. These relays can be set with varying sensitivities depending on the protection requirements and the characteristics of the electrical circuit being monitored.

b. Overload Relay/Thermal Relay

An overload relay on a transmission line refers to an electrical component used to protect an electrical transmission line from overloads or higher currents than permitted. An electrical transmission line is a network that transmits electrical pow power plants to consum long distances. In this co overload relay acts as a safety device, helping prevent damage to electrical equipment and disruption to the transmission system.

When the electrical load on a transmission line increases beyond its normal capacity, the electrical current also increases. If the current exceeds safe limits, cables and other components can overheat, which in turn can cause serious damage or even fire. This is why overload relays are important, as they respond to this increased current by automatically cutting off the

electrical current to prevent further damage.

An overload relay typically uses a current sensor to measure the current flowing through a transmission line. When the current exceeds a predetermined threshold, the overload relay sends a signal to cut off the flow of electricity. This can be achieved using an electromagnetic or electronic switch, depending on the relay's design and technology. The use of overload relays on transmission lines is crucial for maintaining the integrity and safety of the overall electrical system. By quickly detecting and responding to overloads, equipment damage and disruptions that could impact the power supply to consumers can be prevented.



Gambar 4. 2 Overload Relay / Thermal Relay

c. Directional Overcurrent Relay

A Directional Overcurrent Relay (ODR) is a type of relay used in electrical protection systems to detect and address faults or excess currents in the electrical network. This relay is designed to operate a circuit breaker when the current exceeds a predetermined threshold and is in a predetermined direction.

One of the key features of a Directional Overcurrent Relay is its ability to detect the direction of current flow. This is crucial in complex electrical systems, such as transmission and distribution networks, where there are many different branches and paths. This relay ensures that when a fault or overcurrent occurs, the circuit breaker located near the point of the fault or overcurrent is activated, while the circuit breaker in the rest of the system remains operational.

Directional Overcurrent Relays are typically programmed to respond to current exceeding a threshold in a specific direction. For example, if current flows through the relay in the direction consistent with normal flow, the relay may not operate even if the current exceeds the threshold. However, if current flows in a direction inconsistent with normal flow (for example, reverse flow), the relay will operate immediately and disconnect the associated circuit breaker.

This relay helps prevent further damage to electrical equipment and protects the integrity of the overall system. It is also an essential part of a comprehensive protection system to deal with various types of disturbances in the electrical system.



Gambar 4. 3 Directional Overcurrent Relay

d. Differential Relay

differential relay is a protective device used in electrical power systems, including transmission lines and substations. Its function is to detect and respond to an imbalance in electrical current between two or more lines or lines that should have a balanced current. On transmission lines and substations, the electric current passing through the various lines must be balanced to avoid problems such as interference or other disturbances that can cause damage to equipment and systems, as well as potential hazards to personnel working in the area. Current imbalances can occur due to short circuits, equipment damage, or other disturbances.

Following are some of the main functions of differential relays on transmission lines and substations:

1) Current Imbalance Detection : Differential relays monitor the current entering and leaving multiple lines or devices within a system. If there is a significant difference between the currents entering and leaving the lines that should be balanced, the relay will detect this imbalance.
2) Fault Protection : A current imbalance can indicate a problem such as a short circuit or equipment failure. A differential relay will provide a warning or take immediate action, such as interrupting the current flow or isolating the faulty section, to protect the system and prevent further damage.
3) Fault Isolation : If a significant current imbalance is detected, a differential relay can issue a command to isolate the faulty section from the rest of the system. This helps prevent the fault from spreading to other parts of the network, which could cause widespread outages.
4) Post-Fault Recovery : Once the fault has been resolved, differential relays assist in returning the system to normal. This may involve re-establishing current flow or restoring the power

supply after the fault has been resolved.

5) Reporting and Monitoring : Differential relays often feature remote reporting and monitoring capabilities. This allows system operators to remotely monitor the performance of transmission lines and substations and take rapid action if necessary.

Overall, differential relays are important components in electric power systems that help protect equipment, prevent disturbances, and maintain the reliability of the electrical system on transmission lines and substations.

e. Overvoltage and Undervoltage Relays

Overvoltage (OV) and Undervoltage (UV) relays are safety or protection devices used in electrical systems to protect electrical equipment and devices from voltages that are outside the safe or normal range.

1) Overvoltage (OV) Relay : An overvoltage relay monitors the voltage in an electrical system and is responsible for identifying situations where the voltage exceeds a set limit. When the voltage exceeds a specified threshold, the relay will trigger a protective action, such as disconnecting the circuit or providing a warning to the operator. Overvoltage can occur for several reasons, such as lightning, power plant failures, or problems in the electrical distribution system.

2) Undervoltage (UV) Relay : An undervoltage relay acts as a safeguard for situations where the voltage in an electrical system falls below a threshold considered safe. This can occur for various reasons, such as the sudden removal of a heavy load, a power plant fault, or a problem in the electrical distribution system. The relay detects these situations and triggers protective action, such as disconnecting the circuit or providing an alert to the operator.

Both types of relays are important parts of a larger electrical protection system, and they contribute to maintaining the reliability and safety of electrical equipment and preventing damage that may occur due to excessive or insufficient voltage fluctuations.



Gambar 4. 4 Overvoltage and Undervoltage Relay

4. Closing

5.1 Conclusion

From the results of the research "STUDY OF RELAY USE ON THE TRANSMISSION LINE OF THE TELE SAMOSIR MAIN SUBSTATION" it can be concluded that:

1. Importance of Protection Relays: Protection relays are important devices in electrical systems to protect equipment and systems from disturbances or abnormal conditions that can threaten the safety and reliability of operations.

2. Purpose of Using Protection Relays: The use of protection relays in transmission lines at Tele Substations has several main purposes, including equipment protection, fault detection, automatic control, system engineering, and system condition monitoring.
3. Types of Relays: Protective relays in transmission lines include general protection relays, differential relays, directional relays, and distance relays. Each type of relay has a different role and working principle according to its function.
4. Relay Operation Criteria: Relays must respond quickly to disturbances or abnormal conditions in the transmission line. Reliability, sensitivity, response speed, and directional accuracy are important criteria in the operation of protective relays.

5.2 Suggestion

1. Routine Maintenance: Protective relays must undergo regular routine maintenance, including inspection, calibration, and replacement of necessary components. Proper maintenance will ensure reliable performance.
2. Operator Training: Operators responsible for the protection system must be trained in the operation, setup, and maintenance of the protective relays. Operator knowledge will minimize errors and operational problems.
3. Relay Coordination: Protective relays must be properly configured to ensure proper coordination with other protective relays in the system. This will avoid unnecessary tripping and ensure effective protection.
4. Parameter Adjustment: The protective relay must be set appropriately according to the characteristics of the transmission line. Parameter adjustments, such as current and voltage thresholds, must reflect actual operating conditions.
5. Safety: Protective relays must be designed and operated in accordance with applicable safety standards and regulations. Operator and system safety must be a priority.
6. Relay Type Selection: The selection of the type of protective relay should be based on the characteristics and requirements of the transmission line. Be sure to choose the relay type that is most suitable for the environment and operating conditions.
7. Performance Monitoring: Implement a monitoring system to continuously monitor the

performance of protective relays. This will help detect problems quickly and take necessary action.

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