

ABSTRAK

Bambang La Aluwia.

Pengaruh Ketidakseimbangan beban Gardu Distribusi Fasa Netral Berbasis Data Aplikasi
SIMANTRA

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Ketidakseimbangan beban pada sistem distribusi tenaga listrik tiga fasa merupakan salah satu permasalahan yang dapat menurunkan efisiensi dan keandalan transformator distribusi. Ketidakseimbangan arus antar fasa menyebabkan timbulnya arus pada penghantar netral yang berkontribusi terhadap rugi daya (losses) akibat efek pemanasan konduktor (I^2R losses). Penelitian ini bertujuan untuk menganalisis pengaruh ketidakseimbangan beban terhadap arus netral dan besarnya rugi daya pada gardu distribusi dengan memanfaatkan data hasil pengukuran berbasis aplikasi Sistem Monitoring Trafo (SIMANTRA).

Metode penelitian yang digunakan adalah deskriptif-analitik dengan pendekatan kuantitatif. Data yang dianalisis berupa hasil pengukuran arus fasa dan arus netral pada Gardu SFF143 periode tahun 2023–2025. Perhitungan rugi daya dilakukan menggunakan persamaan $P_N = I_N^2 \times R_N$, kemudian dibandingkan dengan standar susut sesuai Peraturan Direksi PT PLN (Persero) No. 0021.P-DIR-2018.

Hasil penelitian menunjukkan bahwa pada periode 2023–2024 persentase losses masih berada di bawah batas standar. Namun pada tahun 2025 terjadi peningkatan signifikan akibat tingginya ketidakseimbangan beban, sehingga nilai losses melampaui batas yang ditetapkan. Hal ini membuktikan bahwa ketidakseimbangan beban antar fasa berpengaruh langsung terhadap peningkatan arus netral dan rugi daya pada transformator distribusi. Pemanfaatan aplikasi SIMANTRA terbukti efektif dalam mendeteksi kondisi tersebut secara dini, sehingga dapat menjadi dasar pengambilan keputusan untuk tindakan penyeimbangan beban guna meningkatkan efisiensi dan keandalan sistem distribusi tenaga listrik.

Kata kunci: ketidakseimbangan beban, arus netral, losses, gardu distribusi, SIMANTRA.

ABSTRACT

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The Effect of Load Imbalance on the Neutral Phase of Distribution Substations Based on Application Data

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Load imbalance in a three-phase electric power distribution system is one of the issues that can reduce the efficiency and reliability of distribution transformers. An imbalance of current among phases causes neutral current to flow through the neutral conductor, contributing to power losses due to conductor heating effects (I^2R losses). This study aims to analyze the effect of load imbalance on neutral current and the magnitude of power losses in a distribution substation by utilizing measurement data obtained from the Transformer Monitoring System (SIMANTRA) application.

The research method employed is descriptive-analytic with a quantitative approach. The analyzed data consist of phase current and neutral current measurements at SFF143 Distribution Substation during the 2023–2025 period. Power loss calculations were performed using the equation $P_N = I_N^2 \times R_N$, and the results were then compared with the loss standards stipulated in the Board of Directors Regulation of PT PLN (Persero) No. 0021.P-DIR-2018.

The results indicate that during the 2023–2024 period, the percentage of losses remained below the standard limit. However, in 2025 a significant increase occurred due to the high level of load imbalance, causing the loss values to exceed the established standard. This finding proves that load imbalance among phases has a direct impact on the increase of neutral current and power losses in distribution transformers. The utilization of the SIMANTRA application has been proven effective in early detection of such conditions, thereby serving as a basis for decision-making regarding load balancing actions to improve the efficiency and reliability of the electric power distribution system.

Keywords: *load imbalance, neutral current, losses, distribution substation, SIMANTRA.*