

## ABSTRAK

Keandalan sistem proteksi pada Pembangkit Listrik Tenaga Air (PLTA) sangat dipengaruhi oleh pemilihan relay yang sesuai dengan karakteristik sistem dan kondisi gangguan. Pemilihan relay yang belum mempertimbangkan berbagai kriteria secara terukur dapat menghasilkan keputusan yang kurang optimal. Penelitian ini bertujuan menentukan relay proteksi yang paling optimal pada PLTA Asahan No. 3 Unit 3 berdasarkan karakteristik sistem kelistrikan dan kriteria evaluasi. Penelitian dilakukan dengan memodelkan sistem kelistrikan menggunakan perangkat lunak ETAP berdasarkan data teknis sistem, kemudian dilakukan analisis *load flow* dan *short circuit*. Analisis hubung singkat meliputi gangguan tiga fasa, satu fasa ke tanah, dua fasa, dan dua fasa ke tanah untuk memperoleh karakteristik arus gangguan. Hasil simulasi digunakan sebagai dasar evaluasi lima kriteria, yaitu Keandalan Operasi, Biaya, Integrasi IEC 61850, Kemudahan Pemeliharaan, dan Kelengkapan Fungsi Proteksi. Pembobotan kriteria dilakukan menggunakan metode *Analytic Hierarchy Process* (AHP), sedangkan pemeringkatan tiga alternatif relay, yaitu MiCOM P343, MiCOM P643, dan MiCOM P141, dilakukan menggunakan metode *Technique for Order Preference by Similarity to Ideal Solution* (TOPSIS). Hasil simulasi menunjukkan bahwa Bus 13,8 kV pada sisi generator memiliki arus hubung singkat terbesar pada seluruh skenario gangguan. Hasil AHP menunjukkan bahwa Keandalan Operasi dan Kelengkapan Fungsi Proteksi memiliki bobot tertinggi, masing-masing sebesar 0,34345, dengan *Consistency Ratio* (CR) sebesar 0,01242 sehingga pembobotan dinyatakan konsisten. Hasil TOPSIS menunjukkan nilai preferensi MiCOM P643 sebesar 0,8923, MiCOM P343 sebesar 0,8390, dan MiCOM P141 sebesar 0,0944. Berdasarkan keseluruhan hasil analisis, MiCOM P643 ditetapkan sebagai relay proteksi yang paling optimal untuk PLTA Asahan No. 3 Unit 3.

**Kata kunci:** ETAP, AHP, TOPSIS, *Relay* Proteksi, PLTA.

## ABSTRACT

*The reliability of protection systems in Hydroelectric Power Plants (HPP) is strongly influenced by the selection of relays that are appropriate to the system characteristics and fault conditions. Relay selection that does not consider multiple criteria in a measurable manner may result in less optimal decisions. This study aims to determine the most optimal protection relay for Asahan No. 3 Hydroelectric Power Plant Unit 3 based on the characteristics of the electrical system and evaluation criteria. The study was conducted by modeling the electrical system using ETAP based on technical system data, followed by load flow and short circuit analyses. The short circuit analysis included three-phase, single line-to-ground, line-to-line, and double line-to-ground faults to obtain fault current characteristics. The simulation results were used as the basis for evaluating five criteria: Operational Reliability, Cost, IEC 61850 Integration, Maintenance Ease, and Protection Function Completeness. The criteria were weighted using the Analytic Hierarchy Process (AHP), while three relay alternatives, namely MiCOM P343, MiCOM P643, and MiCOM P141, were ranked using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The simulation results showed that the 13.8 kV bus on the generator side had the highest short circuit current under all analyzed fault scenarios. The AHP results showed that Operational Reliability and Protection Function Completeness had the highest weights, each at 0.34345, with a Consistency Ratio (CR) of 0.01242, indicating that the weighting process was consistent. The TOPSIS results produced preference values of 0.8923 for MiCOM P643, 0.8390 for MiCOM P343, and 0.0944 for MiCOM P141. Based on the overall analysis, MiCOM P643 was determined to be the most optimal protection relay for Asahan No. 3 Hydroelectric Power Plant Unit 3.*

**Keywords:** ETAP, AHP, TOPSIS, Protection Relay, Hydroelectric Power Plant.