ABSTRAK

Keselamatan operasional reaktor nuklir sangat bergantung pada stabilitas parameter termal, khususnya pada sistem pendingin sekunder. Penelitian ini bertujuan mengembangkan model prediksi suhu outlet (`T-CTB OUT`) pada sistem fluida kerja reaktor nuklir menggunakan metode *Gated Recurrent Unit* (GRU) dengan pendekatan *time series*. Data penelitian diperoleh dari prototipe mesin pemanas air Badan Tenaga Nuklir Nasional (BATAN) sebanyak 11.001 data *real-time*. Melalui tahapan pra-proses dan eksperimen *windowing*, ditemukan bahwa *window size* 24 detik memberikan performa paling optimal. Model dilatih menggunakan lima fitur input hasil seleksi korelasi dan diuji ketahanannya menggunakan skenario injeksi anomali berupa lonjakan (*spike*) dan penurunan suhu mendadak. Hasil evaluasi menunjukkan tingkat akurasi yang sangat tinggi dengan nilai *Coefficient of Determination* (R^2) mencapai 0.991, serta tingkat kesalahan yang rendah dengan MAE 0.025 dan RMSE 0.033. Pada pengujian ketahanan, model terbukti responsif dalam mendeteksi pola fluktuasi ekstrem. Model ini selanjutnya diimplementasikan ke dalam *dashboard* berbasis web sebagai sistem peringatan dini (*early warning system*) yang mampu memprakirakan tren suhu untuk 3.600 detik ke depan. Penelitian ini membuktikan bahwa metode GRU efektif digunakan sebagai instrumen pendukung keputusan dalam pemantauan keselamatan reaktor.

Kata Kunci: Prediksi Suhu, Reaktor Nuklir, *Gated Recurrent Unit*, *Time Series*, Sistem Peringatan Dini.

ABSTRACT

Operational safety of nuclear reactors relies heavily on the stability of thermal parameters, particularly within the secondary cooling system. This study aims to develop a prediction model for the outlet temperature (T-CTB OUT) of a nuclear reactor's working fluid system using the Gated Recurrent Unit (GRU) method with a time series approach. The research data consists of 11,001 real-time data points obtained from a water heater prototype at the National Nuclear Energy Agency (BATAN). Through preprocessing and windowing experiments, it was found that a window size of 24 seconds yielded the most optimal performance. The model was trained using five selected input features based on correlation analysis and tested for robustness using anomaly injection scenarios involving sudden spikes and temperature drops. Evaluation results demonstrated very high accuracy with a Coefficient of Determination (R^2) of 0.991, along with low error rates indicated by an MAE of 0.025 and RMSE of 0.033. In robustness testing, the model proved responsive in detecting extreme fluctuation patterns. Furthermore, the model was implemented into a web-based dashboard acting as an early warning system capable of forecasting temperature trends for the next 3,600 seconds. This study proves that the GRU method is effective as a decision support tool for reactor safety monitoring.

Keywords: *Temperature Prediction, Nuclear Reactor, Gated Recurrent Unit, Time Series, Early Warning System.*