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Research Paper

# FTA Analysis of the Winding in Steam Power Plant: An Insight into the Stator

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***Abstract***— The stator winding generator is a significant equipment in the steam power plant (SPP), which converts mechanical energy into electricity. The windings of the turbine generator were mainly used for power generation, and the failure of the winding caused much damage to the stator. In this paper, fault tree analysis (FTA) was used to determine the initial condition of deterioration of the winding fault. FTA results are preliminary indications of stator fault. The investigation results found the binding tape aging and seal oil generator issues. At some point, the binding tape coils in several slots on the exciter and turbine sides were found as loose binding tape (coil binder) that is not tight (loose) and can be interpreted as aging conditions. The earth stator alarm was also confirmed.

***Keywords***— Alarm Earth Stator Fault, Electric Steam Power Plant, Fault Tree Analysis, Generator Failure.

## 1. Introduction

The Static wind generator is an essential device in the steam power plant (SPP) that converts mechanical energy into electricity [1]. The generator's cooling system was in the stator using water, while the stator core and rotor winding used hydrogen coolant. SPP Rembang-Indonesia (SPP RI) was a two-synchronous generator with an output power of 300 megawatts. The turbine generator used at the SPP RI was a brand of Dongfang Electric model QFSN-300-2-20B type self-shunt static Excitation $H_2O$-$H_2$-$H_2$ (hydrogen-cooled generator unit) made by China Dongfang Electric Machine Co. Ltd. [2], one of the static excitation system of power plant synchronous generator [3].

SPP RI was operated since 2011 and continuously operated well; meanwhile, on May 14, 2021, unit #20 experienced a trip condition marked by a Differential Fault Generator Alarm (DFGA) appearance. After further checking, damage to the steering stator was found. Malfunctions of this generator lead to considerable cost losses [4].

Based on the results of the Root Cause Failure Analysis (RCFA), the damage occurred due to the lifetime of the tape seal [4]. The results of the RCFA allow for inspections related to solving problems in the power plant engine circuit [5]. Consequently, further analysis of the operating parameters that caused damage to the stator must be used as future learning and reference data for logical modification to avoid damage.

## 2. Related Work

Turbine generator set QFSN-300-2-20B was evaluated for an efficiency of about 98%. Unfortunately, this turbine generator reported a decrease in efficiency by about 5% [6]. Another type of turbine generator set called QFSN-350-2, a 350-megawatt generator, was also evaluated for the efficiency impacted by load capacity changes. There are increasing load capacity influences the efficiency of the isentropic. In addition, the efficiency of the turbine generator was influenced by the load capacity changes [7]. Permana and Kurniawan [8] and Dirmanto & Effendi [9] stated that the turbine efficiency would impact SPP performance. High-efficiency value means better system reliability [10].

The time-caused effects of performance quality sometimes affect the turbine generator's reliability. Some issues commonly appeared in the generator case, such as vibrations in the turbine rotor. Research by Romdhon et al. [11] used Root Cause Analysis (RCA) method to analyze that issue. The result showed that a short rotation and a closed slot-liner hole to activate a rotation generated electrical vibration and that it was necessary to fix it to reduce vibration disturbance.

Instead of the generator's rotor winding issue, the stator winding failure reported by Raymond et al. [12] occurred in 51 MVA, 11 kV generator stator, a type of hydro-generator. The investigation reported that the following procedures were obtained, including locating and assessing the fault's extent.

 