Investigation of Various Faults of 500 kV Transmission Line Design in Sarawak, Malaysia Using Power Systems Computer Aided Design

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***Abstract*—This paper deals with a simulation investigation of an extra high voltage transmission line (500 kV) design in Sarawak, East Malaysia using Power Systems Computer Aided Design (PSCAD). Currently, the extra high voltage transmission system in Sarawak is mainly supplied by a 275 kV system covering the whole Sarawak region, starting from Miri district up to Kuching city - the so-called Sarawak Power Grid Backbone. Due to the rapid growth of industries and population in this state within the last ten years, improving the transmission system to become 500 kV is necessary. Therefore, the investigation of transient overvoltage and overcurrent in a new 500 kV transmission line system when faults occur due to various faults on the line and a lightning strike will be important to evaluate the system's reliability. The simulation results revealed that the lightning and three-phase faults cause the highest transient current surge in the transmission line. The highest lightning transient overvoltage was found at the receiving end of the transmission line.**

Keywords— 500 kV single-line to ground fault, double-line to ground fault, three-phase fault, lightning surge, PSCAD simulation.

I. Introduction

The transmission system is an important part of electrical power since this part is for transmitting electrical energy from the power generation site to the electrical load. It was reported that the power losses of the transmission line are increasing from year to year, mainly due to power quality problems like transient overvoltages [1]. Transients are the high unexpected increment in voltages or currents values. The transients might be caused by faults in the line such as single-line to ground fault, lightning strikes as well as line energization. The damage to power lines insulators and supply interruption could be happened due to the oscillatory and impulsive transient waveforms [2-3]. Transient phenomena become one major power quality problems that make power transmission interruption and breakdown. Faults at the substation might be caused by transient overvoltages in the transmission lines.

Much research has been performed on transient overvoltage and overcurrent surge due to various faults including lightning strikes in power transmission lines [4-8]. It is found that 50% of the total system failure in Tenaga Nasional Berhad (TNB) system; a national power company caused multiple trip-outs on the extra high voltage transmission lines annually. The high value of the isokeraunic level in this country is the cause of failure in the transmission system (about 200 thunderstorm days/year)[9]. The keraunic number is a system to describe lightning activity by using thunder audible detection in a specific area. In Malaysia, a typical lighting current is more than 20 kA, while it is around 30 ~ 120 kA of lightning current might occur which strikes the transmission line system [10].

The main objective of this research work is to investigate the performance of Sarawak 500 kV transmission line design due to various faults, namely single-line to ground, double-line to ground, line to line, three-phase faults, lightning surges as well as line energization by employing Power System Computer Aided Design (PSCAD) software. The model of faults and their transients' waveforms profiles will be conducted systematically in this study. The result hopefully