Transient Overvoltage Simulation in 500 kV Transmission Line Plan of Sarawak, Malaysia using PSCAD

Yanuar Z. Arief, Nur Izziani Roslan, Mohd Hafiez Izzwan Saad, Lakshmanan Gurusamy, Nor Asiah Muhamad

Abstract*: Transmission system is a crucial system in electrical power since the system transmit the electricity from power generation to consumer load. According to World Bank, the power losses from transmission lines are rapidly increasing from year to year at the rate of 3.85% in the year of 2013 to 5.792% in 2014. Losses in transmission system are most likely from power quality problems such as transients. Transients are the outcome of high unexpected increment in voltage or current surge magnitudes. The peak values of both voltages and current are usually more than twice of that normal voltage and current amplitudes. The surges due to transients can vitally cause power system failure and breakdown of electrical equipment especially at the substations. There were few known transient overcurrent and overvoltage problems, which are due to faults, lightning and line energizing, respectively. This research work mainly focuses on simulating transients for 500 kV transmission system which employ Sarawak as the case study location. Sarawak currently has main 275 kV transmission line covering the whole Sarawak from Miri to Kuching known as Sarawak backbone, but due to lots of industries and rapid development and urbanization boom in Sarawak, there is a planned of 500 kV transmission line as a backup if the 275 kV transmission line proves inadequate. In Sarawak, the 500 kV is planned to be energized at 275 kV. But, in fact this work is for that transmission line to be operated at 500 kV, hence, monitoring the highest transient may occur. The results revealed that lightning and three-phase faults of 1.0 s fault time duration cause the highest change in amplitude of current on the line up to 9.06 pu and 9.27 pu, respectively. The highest lightning amplitude is observed when lightning was simulated at the receiving end of the line which is near to the Tada substation.

***Keywords* : 500 kV transmission system, substation, switching surge, lightning surge, PSCAD.**

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***** Correspondence Author

Yanuar Z. Arief*, Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS), 94300 Kota Samarahan, Sarawak, Malaysia. Email: ayzulalrdiansyah@unimas.my

Nur Izziani Roslan, Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS), 94300 Kota Samarahan, Sarawak, Malaysia. Email: ayzulalrdiansyah@unimas.my

Mohd Hafiez Izzwan Saad, Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS), 94300 Kota Samarahan, Sarawak, Malaysia. Email: ayzulalrdiansyah@unimas.my

Lakshmanan Gurusamy, Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS), 94300 Kota Samarahan, Sarawak, Malaysia. Email: ayzulalrdiansyah@unimas.my

Nor Asiah Muhamad, School of Electrical and Electronic Engineering, Universiti Sains Malaysia (USM), 14300 Nibong Tebal, Penang, Malaysia. Email: norasiah.m@usm.my

I. INTRODUCTION

Transmission lines are integral part of generation, transmission, and distribution of any power generating plants to consumer loads of grid network. These transmission lines have been used since 19th century by using hydraulic transmission to deliver power to power up industries. In Malaysia, there are six main voltage range for distribution and transmission system, which are 415 V or 400 V, 11 kV, 33 kV, 132 kV, 275 kV and 500 kV, respectively. The 500 kV transmission line is the main transmission for some places in Peninsular Malaysia (West Malaysia) while as a plan of transmission grid for Sarawak (East Malaysia), covering from Similajau to Tondong with approximate length of 505 km in total [1]. The predominant reason for a higher voltage transmission line is to reduce power losses especially for long distance transmission of electricity.

In recent times, the power quality problems constitute the prior causes to power losses during power transmission. There are several types of power qualities such as transients, harmonic, noise, flicker, voltage swell and voltage sag. Power quality is defined as the concept of grounding and powering electronic equipment in a way that is acceptable to the operation of that equipment in accordance with the wiring system of the premise and other connected equipment [2-3]. Meanwhile, transient is defined as voltage or current having impulsive nonrecurring changes in the magnitude. An impulse transient is described by the time to decay to half of its peak value and time to reach peak value, usually caused by lightning [4-6]. The transients are known to occur due to faults, lightning and line energizing. An oscillatory transient can cause damage to power line insulators while an impulsive transient can cause equipment damage at the point of inception [7-8]. Transient is one of main power quality problem that can interrupt power transmission and at some point, can cause electrical breakdown.

Power system computer aided design (PSCAD) is a software to simulate and design the power system with comprehensive library ranging from simple elements to complex devices. With the development of simulation tools and new system models, simulation achieves such realistic interpretation of actual conditions in a network while in real-time,