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Voltage uprating of existing high voltage substations when transient voltage stress and available withstand strength are coordinated

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ABSTRACT

Servitude availability in space-constrained built-up areas within the Johannesburg or Central Load Network (CLN) poses every-day challenges for power system engineers. Strengthening the backbone 88/275 kV transmission system within the CLN becomes even more difficult when multi-circuit transmission lines are required for increased power transfer capabilities. When uprating is considered to increase the power transfer capability, the withstand levels of existing external insulation demands an optimisation to find a new stress versus strength balance that allows reliable operation of substations at higher voltages. The research includes primarily an investigative simulation study to evaluate the current Eskom available design clearances in terms of their withstand capability when subjected to over-voltage transients. Two voltage range classes were evaluated and the results are discussed. For voltage range 1, it was found that the over-voltage stress was low enough to allow for a higher nominal operating voltage while maintaining the existing clearances. For voltage range 2, existing clearances are also found to be conservative and smaller safety margins will most likely be acceptable. From a transient analysis evaluation, voltage uprating is considered as a very attractive option to increase the power transfer capability of existing substations. Current Eskom clearances for 88 kV and 275 kV are expected to perform well during transients generated in uprated systems. Electrode grading to improve the field gradients in the substation will require attention to increase gap factors. Additional surge arresters are considered to be a cost effective solution to control over-voltages throughout the whole uprated substation. The physical modification of substations to replace strung conductors with tubular conductors, ensuring sufficient outage time to refurbish and rebuild with new equipment will be the most challenging part of uprating existing substations.