Definition and Implementation of Voltage Stability Indices in PSS®NETOMAC

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Abstract

This thesis discusses important aspects related to voltage stability indices and their uses in electric power system analysis and operation. Some indices previously studied in the literature have been reviewed and implemented in a reduced local network such as Line Stability Index (L_{mn}), Voltage Collapse Prediction Index (VCPI), and Power Transfer Stability Index (PTSI). In this thesis, a new index, Approximate Collapse Power Index (ACPI), is proposed based on quadratic approximation of PV-curves. All indices have been calculated and compared with the existing Siemens's voltage stability criteria, Local Load Index (LLI) and Phase Angle Index (PAI), derived for the reduced local network. The performances of the indices were investigated for both steady-state and dynamic analyses through the IEEE 9-bus test system and a larger test network including 119 generators and 414 nodes using Power System Simulator and Network Torsion Machine Control (PSS®NETOMAC) software from Siemens. A comparison of the indices regarding to sensitivities, and calculation times has been done. The results have shown that the performances of these indices are corresponding to one another regarding to voltage stability of the power system. All indices were found to be between 0 and 1 in their intended ranges. When the system is voltage stable, these indices are closed to 0. When the system is in critical condition with regard to voltage instability, the indices moved closed to 1, but at different levels of convergence. The existing Siemens's voltage stability criteria were found less sensitive compared to other indices in the study. They, however, have advantages of shorter calculation time, especially the PAI index. The proposed ACPI index was found the most sensitive one towards voltage instability. However, ACPI index requires the longest computational time. The ACPI index is recommended to be implemented in the voltage stability assessment module in PSS®NETOMAC.

Key words: Voltage stability, voltage stability indices, P-V curves, dynamic simulations.