DYNAMIC OVERVOLTAGES DUE TO LOAD REJECTION IN POWER SYSTEMS

by

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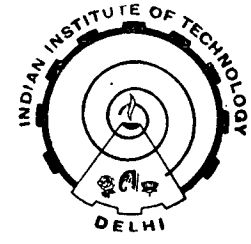

CENTRE OF ENERGY STUDIES
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DEDICATED TO

THE MEMORY OF

MY FATHER SHRI BALAK RAM

AND

MY MOTHER SHRIMATI RAMAVATI DEVI

CERTIFICATE

Certified that the thesis entitled, "Dynamic Overvoltages due to Load Rejection in Power Systems", which is being submitted by Shri Babu Ram in partial fulfilment for the award of the degree of Doctor of Philosophy in Centre of Energy Studies of the Indian Institute of Technology, Delhi is a record of the student's own work carried out by him under our supervision and guidance. The matter embodied in this thesis has not been submitted for the award of any other Degree or Diploma.

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The thesis is based on the following papers published by the author :

1. Data Acquisition and Monitoring of Micro-Alternator, J.I.E.(India), Vol. 62, pp. 101-107, Dec. 1981.
2. Real-Time Torque Angle Monitoring of Micro-Alternator, J.I.E.(India), Ref: EM-697 (Accepted for Publication, 1982).
3. Microprocessor Based Governor for Steam Turbine, J.I.E.(India), Ref : CP-690 (Accepted for Publication, 1983).
4. Interfacing of Micro-Alternator with Micro-Computer for Real-Time Monitoring, (Communicated to IJEEE (England), 1983).
5. Temporary Overvoltages Due to Load Rejection on a Series Compensated Line , Proc. IEE, Vol.130, Part C, No.1, pp. 8-15, Jan. 1983.
6. A Study of Self-excitation on a Series Compensated Line and its Control (Communicated to IEEE Summer Meeting, 1983).
7. Control of Dynamic Overvoltages due to Load Rejection by Static Shunt Compensation (Communicated to International Journal of Electrical Power and Energy Systems, England, 1983).

ABSTRACT

A method of analysis for computing dynamic overvoltages following load rejection is presented in this thesis. The method incorporates detailed dynamic models of synchronous machine, excitation system and transmission network. The problem is simulated on ICL 2960 computer system. The receiving end voltage envelopes following load rejection have been evaluated for a typical 400 kV system for different models of synchronous machines using the digital computer program. These studies reveal the need for detailed representation of machine and excitation control system as otherwise rate of decay of overvoltage response becomes considerably slower.

This kind of study is very useful for choosing the voltage rating of the current limiting gap type surge arresters which have the capability to discharge repetitively a few times and reseal against dynamic overvoltages.

Furthermore, the performance of excitation systems, viz. static excitation system and D.C. rotating system in the control of dynamic overvoltages due to load rejection is studied. Next, the effects of various parameters, such as line length, power factor of the load rejected and exciter-amplifier gain on dynamic overvoltages are studied.

The analysis is further extended to include series compensation on transmission lines. Receiving end voltage envelopes following

load rejection on a series compensated network are presented in this thesis for different degrees of series compensation, line loads and excitation systems. These results reveal the occurrence of self-excitation in the particular power system considered when the compensation level reaches 70 percent. Hence these studies are useful for choosing safe series compensation level for a particular system.

Furthermore, the performance of static compensator as a device for control of dynamic overvoltage is studied in this thesis. The regulator employed in the static compensator control scheme is a proportional plus integral type. The effect of control parameters such as gain and integration delay of P-I regulator is investigated for a typical 400 kV system.

The effect of shunt reactors on dynamic overvoltages both for series compensated and nonseries compensated networks is analysed in this thesis. The performance of joint series plus static shunt compensation is also studied in this thesis. These studies are useful for selecting kind and quantum of compensation required for a particular power system.

The application of this analysis for choosing economic voltage rating of surge arrester which is to be installed in an EHV station is presented.

A real-time technique for on-line monitoring of overvoltages following load rejection is also presented in this thesis. This

technique has been implemented on a microcomputer interfaced with a model synchronous generator which delivers power to a load through a model transmission line. This technique may be used for monitoring overvoltages in a load rejection field test conducted on a real power system.

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