Faculty Of Engineering

OPTIMAL SECURITY CONSTRAINED HYDRO - THERMAL SCHEDULING

BY

Eng. KAMEL YASSIN ALY MOUSTAFA

A Thesis

Submitted In Fulfillment For The

Requirements Of The Degree Of PH.D.

In Electrical Engineering

Supervised By

Prof. Dr. ALI K. EL_KHARASHI
Head Of Electrical P & M Dep.
Faculty Of Engineering
Ain Shams University

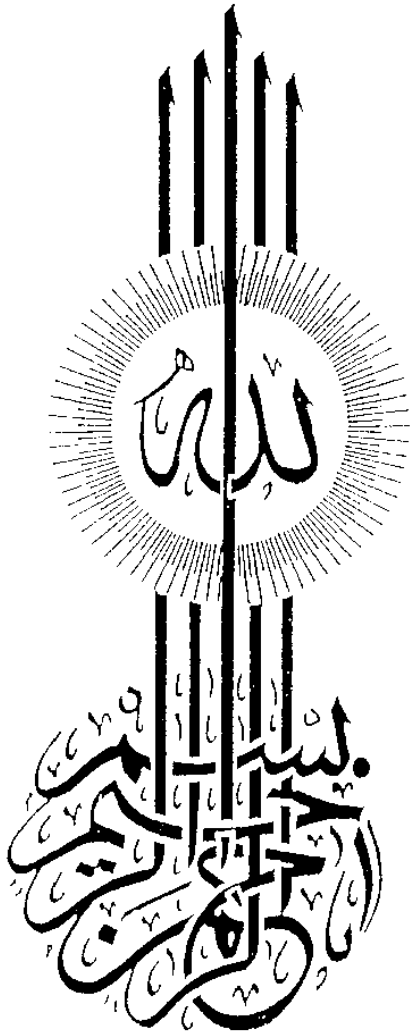
Dr. HAMDY M. EL_SHAER
Chairman
Elect. Power Systems
Engineering Company

Dr. HASSAN A. YOUNES
Inspector General
National Energy Control Center
Egyptian Electricity Authority

Cairo 1989

EXAMINERS COMMITTEE

Name, Title & Affiliation	Signature
1. Dr. Hans R. Fankhauser Manager Production Planning and Control Applications Power System Control Development ASEA Transmission SWEDEN	
2. Prof. Dr. M.A. El-Sharkawy Electrical Power and Machines Dept. Faculty of Engineering Ain Shams University	٨٩/٧/٢
3. Prof. Dr. Ali K. El-Kharashi Head of Electrical Power and Machines Dept. Faculty of Engineering Ain Shams University	Kharashi 2.7.89
4. Dr. Hamdy M. El-Shaer Chairman Electric Power Systems Engineering Company	H.M. Elshaer
5. Dr. Hassan A. Younes Inspector General National Energy Control Center Egyptian Electricity Authority	


بسم الله الرحمن الرحيم

STATEMENT

This dissertation is submitted to Ain Shams University for the Ph.D. degree in Electrical Engineering.

The work included in this thesis was carried out by the author in the department of Electrical Power and Machines, Ain Shams University, from 09/12/ 1985 - 31 /03/1989.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Name : Kamel Y. A. Moustafa

Signature: KM

Date : 2-7-89

ABSTRACT

Scheduling electric power in a system containing both hydro and thermal units is a complicated and challenging problem mainly because of the different operating characteristics of thermal and hydro plants.

Thermal plants operate at a substantial marginal cost with no restrictions on the total energy that can be generated over certain period within the limits imposed by capacity and availability . On the other hand hydro plants operate at negligible marginal cost, but their energy production is subject to strict limitations imposed by reservoir storage, inflow , and releases.

The basic problem is to find an optimal startup/ shutdown schedule of thermal units and the hourly power dispatch from the hydro and thermal units in the system so that the total production cost, measured in terms of thermal fuel economy, is minimized over appropriate period of time in a manner consistent with reliable service within the limits imposed by constraints.

This research presents the methods used in developing daily operational strategies for the hydro-thermal system of Egypt considering transmission limitations. The algorithm decomposes the problem into a hydro and a thermal subsystems. The hydro subsystem is solved via the combination of a heuristic and a

ACKNOWLEDGEMENTS

In developing this thesis, I have benefited from the guidance of prof. Dr. Ali K. El-Kharashi, Dr. Hamdy M. El-Shaer and Dr. Hassan A. Younes.

My gratitude, and sincere appreciation are expressed to prof. Dr. El-Kharashi for his constructive criticism and support, as well as his valuable guidance and fruitful discussions throughout the course of this work.

I am specially indebted to Dr. El-Shaer, whose inspiring guidance, constant encouragement and suggestions have been extremely valuable during the course of this work.

Dr. Younes assistance was crucial during all the stages of this work. Working closely with him, I would like to express my sincere appreciation for his outstanding support and valuable advices throughout the course of this work.

The author thanks Dr. Emad El-Sharkawy , EEA chairman for his long- standing support and encouragement for all research efforts ongoing within EEA.

The author's grateful appreciation is extended to the colleagues in the National Energy control Center of Egypt for their help and encouragement.

dynamic programming techniques. The thermal subsystem is solved via a lagrangian relaxation technique. Transmission constraints are checked by a DC load flow model, violations are relieved using a dual linear programming generation shift algorithm.

This research brings a new contribution on this complicated subject in the following areas:

- A new approach to update lagrange multipliers
- A practical approach to relieve transmission overloads
- Reliable distribution of spinning reserve
- Reduction of execution time

The procedures developed in this work constitute a very powerful methodology for optimizing a combined hydro-thermal generation system with transmission limitations. Although every system has its own particular characteristics, the basic concepts can be applied to any system. The new method used in updating the lagrange multipliers improved the solution speed drastically without tolerating the accuracy, and led to reliable distribution of spinning reserve among all the units. Also the inclusion of security aspects within the complicated problem of scheduling has been efficiently treated to suit the requirements of realistic size systems.

Finally, the test results and conclusions from the application of the developed procedures on the Egyptian hydro-thermal system have revealed their efficiency as a tool for decision making in the operation planning process.

TABLE OF CONTENTS

page

CHAPTER 4 :MODELLING FOR SHORT-TERM OPERATION OF A HYDRO-THERMAL POWER SYSTEM

page

page

LIST OF FIGURES